MEN AND MEASURES

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A HISTORY OF
WEIGHTS AND MEASURES
ANCIENT AND MODERN

BY

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PREFACE

This history is the development of a short story of the Imperial System of Weights and Measures pub-

ERRATA.

Page 36	*Line* 21	*For* "x1000"	*Read* "x7000."
,, 136	,, 21	,, "grams"	,, "grains."
,, 148	,, 27	,, "7925"	,, "7625."
,, 154	*Lines* 21, 22, 23	*delete* "to."	
,, 155	*Line* 4	*For* "feet"	*Read* "ells."
,, 195	,, 15	,, "17"	,, "25."
,, 198	,, 19	,, "double"	,, "halve."
,, 263	,, 13	,, "perches"	,, "toises."
,, 295	,, 16	,, "apposes"	,, "opposes."
,, 306	*last line*	,, "our"	,, "yours."

PREFACE

THIS history is the development of a short story of the Imperial System of Weights and Measures published eleven years ago, but withdrawn when this fuller work took shape. To have made it at all complete would have required a long lifetime of research; to give and discuss every authority, to trace, even to acknowledge, every source of information would have unduly swollen the volume and slackened the interest of the narrative. I offer it with all its shortcomings as an attempt to show the metric instincts of man everywhere and in all time, to trace the origins and evolution of the main national systems, to explain the apparently arbitrary changes which have affected them, to show how the ancient system used by the English-speaking peoples of the world has been able, not only to survive dangerous perturbations in the past, but also to resist the modern revolutionary system which has destroyed so many others less homogeneous, less capable of adaptation to circumstances.

E. N.

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TABLE OF CONTENTS

CHAPTER I

CHAPTER II

THE STORY OF THE CUBITS

CHAPTER III

THE STORY OF THE TALENTS

Missing Page

Missing Page

CHAPTER XI

SCOTS, IRISH, AND WELSH MEASURES AND WEIGHTS

CHAPTER XII

MEASURES AND WEIGHTS OF SOME BRITISH DOMINIONS

CHAPTER XIII

MEASURES OF VALUE

CHAPTER XIV

MEASURES OF TIME

CHAPTER XV

CHAPTER XVI

CHAPTER XVII

FOREIGN LINEAR MEASURES

CHAPTER XVIII

FOREIGN WEIGHTS

CHAPTER XIX

FOREIGN MEASURES OF CAPACITY

CHAPTER XX

THE DEVELOPMENT OF MEANING IN THE NAMES OF WEIGHTS AND MEASURES

CHAPTER XXI

THE OLD MEASURES AND WEIGHTS OF FRANCE

CHAPTER XXII

CHAPTER XXIII

CHAPTER XXIV

THE CONFLICT OF THE IMPERIAL AND METRIC SYSTEMS

MEN AND MEASURES

CHAPTER I

GENERAL VIEW

THE earliest measures were those of length, and they were derived from the rough-and-ready standard afforded by the limbs of man.

The readiest of these measures were those offered by the length of the forearm, and by parts of the hand; these formed a natural series of far-reaching importance.

These arm-measures were—

1. The Cubit, the length of the bent forearm from elbow-point to finger-tip, about 18 to 19 inches.

2. The Span, the length that can be spanned between the thumb-tip and little finger-tip of the outstretched hand. It is nearly half of the cubit, about 9 inches.

3. The Palm, the breadth of the four fingers, one-third of the span, one-sixth of the cubit, about 3 inches.

4. The Digit or finger-breadth at about the middle of the middle finger, one-twelfth of the span, one-twenty-fourth of the cubit = $\frac{3}{4}$ inch.

From this division of the cubit into 6 palms and 24 digits, and of its half, the span, into 12 digits, came the division of the day into watches and hours, of the year into months; came also the consecration of the number 12 in legend, history, and social institutions—came in short duodecimalism wherever we find it.

Add to the above measures the outstretch of the arms, the fathom, we have the five primitive limb-lengths.

A time came when civilisation required the fixing of a standard cubit. It was perhaps at first an arbitrary standard, but it became fixed by law in the most ancient Eastern Kingdoms and, about the fortieth century before the Christian era, perhaps much earlier, certainly by the time of the Egyptian fourth dynasty, it had been fixed at a length known for certain to be equal to 18·24 English inches.

This was no arbitrary standard, any more than that of the English yard or the French metre. I may say that, apart from parochial varieties and convenient trade-units, always referable to some recognised standard, there are no arbitrary standards in any country; all have a directly scientific basis or a lineage reaching, perhaps far back, to a scientific basis. They may have deviated, by carelessness, or even by petty fraud, from some accepted standard, but wholesale trade has always been a conservator of standards.

There is not the slightest doubt that the common cubit of ancient Egypt, brought probably from Chaldæa, was deduced from the measurement of the earth, from

the quarter-meridian distance between the pole and the equator. There are no written records of this measurement ; but an imperishable monument remained to record it, and other ancient monuments still remain to corroborate this testimony. The base of the Great Pyramid was, from ancient times, always known to be 500 cubits long on each side, and it is found to be exactly half a meridian mile, or 500 Egyptian fathoms, in perimeter.

There is no doubt that the wise men of the ancient Eastern Kingdoms had great astronomical knowledge and were capable of making the necessary meridian measurement.

Bailly (author of 'Histoire de l'Astronomie,' 1775–1787) wrote :

> The measurement of the earth was undertaken a vast number of ages ago in the times of primitive astronomy. . . . We pass contemptuously by the results of ancient astronomical observations ; we substitute others and, as we perfect these, we find the same results that we had despised.

It will be seen that these ancient observations were of great accuracy, and that modern science cannot improve much on the measurements of the meridian that were made on the plains of Chaldæa, or along the Nile, at least sixty centuries ago.

The unit of distance used at the present day by seamen of all nations, the meridian mile, one-sixtieth of a degree, is exactly 1000 Egyptian fathoms, or 4000 Egyptian meridian cubits, and the Great Pyramid was built with a base measuring exactly 500 of these

cubits along each side and 500 of these fathoms in perimeter.

It had probably been found convenient before that time to take a shorter unit than the cubit for use in many everyday measurements. It was two-thirds of the cubit, one-sixth of the fathom, and was called a Foot from its being roughly about the length of a long human foot. Apparently one of the primitive limb-measures, it is really an outcome of the cubit, 'foot' being merely a convenient name for it. The foot of the meridian cubit was of 4 palms or 16 digits and was = 12·16 English inches.

The Egyptian standards of linear measure, thus adjusted to the meridian mile, passed to Greece, and under the name of 'Olympic' became the Greek standards of length.

The use of the cubit and foot series of measures is seen in Hesiod (ninth century B.C.):

> Hew a mortar three feet (*tripodīn*) in diameter, and a pestle three cubits (*tripichtēn*), and an axletree seven feet (*heptapodīn*) . . . and hew a wheel of three spans (*trispithamon*) for the plough-carriage of ten palms (*dekadōro*) length.

Besides the original division of the foot into 16 finger-breadths or digits, there arose an alternative division into 12 thumb-breadths or inches. So for the Roman foot, of shorter standard than the Egyptian or Olympic foot from which it was derived—

> Pes habet palmos iv, uncias xij, digitos xvi,
> Palmus habet digitos iv, uncias iij.

It may be said that with the foot originated the sexdecimal system, as with the span the duodecimal system. But the foot had as many inches, twelve, as the span had of digits; and this division was the same in other feet or spans not differing much from the Olympic standard.

The popularity of the foot, its general adoption for the common purposes of life, are due to its being divided into either 12 inches or 16 digits, the familiar thumb-breadths and finger-breadths. Every popular system meeting the convenience and the ways of thought of men and women, must have its measures of length approximately coinciding with the familiar units of limb-lengths, and it must be divided sexdecimally or duodecimally to enable people, men, women and children, to calculate mentally in the everyday business of life.

The octonary or semi-sexdecimal mode of division seen in our Pint-Gallon-Bushel series is also very convenient, especially for measures of capacity and for land-measures, admitting extensive halving and quartering with subordinate units at each division. Duodecimal division having the convenience of thirding is convenient for the coinage series. A combination of the score and dozen series, as in our money-pound of 20×12 pence, combines the advantages of extensive halving and thirding.

But never has man taken to a decimal series of weights and measures; he may use them on compulsion, and then will evade them whenever he can. He has ten fingers, whence decimal numeration from the

earliest times; but he has always rejected decimal measures.[1]

If to the inconvenience of not being able to halve a unit more than once (and that only as a concession to unscientific weakness of mind), so that there is an interval of ten units between each named unit of the series, be added that the familiar units of common life, the thumb-breadth, the span, the foot, the pound, the pint, have no representatives in a decimal system, then no cajolery of science or patriotism will persuade men and women to use the system, except under police compulsion, and every trick will be used to evade it. Such are the ways of the human mind. Systems that are suited to popular convenience, both in wholesale and retail trade; systems that admit of modification and improvement—these will live. Systems imposed by police-force in which the people must fit themselves to the system—these are bound to fail.

The convenient foot being taken as subsidiary to the cubit, it afforded, for long measurements, larger units which harmonised with the cubit, and with its half, the span. The most usual long unit has been the Fathom and its double—

The Fathom	4	cubits	or	6	feet	or	8	spans
The Reed or Rod	8	,,	,,	12	,,	,,	16	,,

This Rod, varying according to the local standard of the foot or the span, is that nearly always used in countries round the Mediterranean. In northern

[1] Even in numeration he often prefers to count by the score. The Welshman says *dega-dugain* (10 and 2-score), the Breton *quarante et dix*, other Frenchmen *quatre-vingt-dix* (4 score and 10).

countries where the foot has superseded the span for measures of any length, 16 feet instead of 16 spans is a usual length for the rod-measure.

It is a curious fact in the history of human nature that neither ancient Egypt nor the other Eastern monarchies kept to the meridian cubit and the measures based on it. While it survived in Greece, it was abandoned, officially at least, in Egypt, Assyria, and Persia. Influences in which science was mixed with astrolatry caused a second cubit to arise, even at the time of the building of the Great Pyramid, and this cubit superseded the meridian cubit as the official standard of the Eastern Kingdoms. Centuries passed and other cubits, not many, five or six at the most, arose through analogous influences. From these Eastern cubits, and from the Roman linear measures based on a mile eight-tenths of the meridian mile, all the various systems of the civilised world have been evolved.

From linear measures, the fathom and the rod, came measures of surface which, quickly in some countries, slowly in others, superseded more primitive estimates of cultivated area. A very usual unit of land-length and of road-distance was the customary length of the furrow. In all times and countries the peasant has found that a certain length of furrow, often about 100 fathoms or 50 rods, was convenient for himself and his plough-cattle. A strip of land of this length, and of one or more rods in breadth, would become a unit of field-measurement, and in time this superficial extent, in some shape or other, would become a geometrical standard.

Commerce, even of the most primitive kind, led to two other forms of measure—to Weight and Capacity. The capacity of the two hands, that of a customary basket or pot, that of the bottomed cylinder obtained from a segment of well-grown bamboo, would be superseded by that of a vessel containing a certain weight of corn, oil or wine, as soon as the goldsmith had devised the balance. Seeds of generally constant weight such as those of the locust-tree, used for weighing the precious metals, would soon be supplemented by a larger standard for heavier weighing; and the weight of a cubic span or a cubic foot of water would afford a suitable unit. A vessel containing a cubic foot of water thus afforded a standard, the Eastern Talent, both for weight and for capacity. The cubic foot would become a standard for the measure of oil or wine, while this measure increased, usually by 22 or 25 per cent., so as to contain a talent-weight of corn, generally of wheat, would become the Bushel or otherwise-named standard of capacity, for the peasant and for corn-dealers.

The peasant would use his bushel not only to measure his corn, but also to estimate his land according to the measure of seed-corn it required. He would also take a day's ploughing on a customary length of furrow, as a rough measure of surface, and the landlord would estimate the extent of his property by the number of yoke of plough-cattle required to work it. These seed-units and plough-units would in time be fixed, and thus become the basis of agrarian measures.

In the meantime coinage would have arisen. A

subdivision of the talent would become the pound or common unit of weight in the retail market, and a subdivision of the pound would be fixed as the weight of silver which, impressed with signs guaranteeing its fineness, if not its actual weight, would be the currency of the merchants.

Then arose, by involution, another system of weights in which the pound was usually of 12 or 16 ounces, and the ounce was the weight of so many standard coins. Every modern pound was based on this system. But again, the pound of silver would yield a certain number of coins, giving rise to a new monetary system under which the coin-origin of the pound would in time be forgotten.

The necessary state-privilege of coining money sometimes led to differences between mint-weight and commercial weight. Just as there arose in the ancient East a royal or sacred cubit different from that in vulgar use, so there arose in many countries a royal pound used in the mint and different from the vulgar commercial weight. In many countries, ancient and modern, the mint has kept up systems of weight consecrated by tradition but obsolete for all other uses, and out of harmony with commercial weight.

The scientific measurement of time had early been established by the astronomers who had measured the meridian.

The skilled artisans who constructed astronomical instruments and the standard measures of capacity and weight must have observed that the water contained in the standard measure of capacity weighed

more when it was as cold as possible than when at the temperature of an Eastern summer; they could not fail to develop the idea of thermometry thus made evident to them. Nor could anyone fail to see that oil was lighter than water, strong wine than unfermented, and spring-water than brine or sweet juices. Some means of aræometry, by an immersed rod or bead, would be devised to avoid the trouble of finding their density by the balance.

It may thus be said that the scientists and skilled artisans of very ancient Eastern lands were fully as capable of constructing a scientific system of weights and measures as Western Europeans in our eighteenth century.

Good systems were carried by commerce to less advanced countries; if convenient they took root, partially or entirely, and, with such modifications as circumstances caused or required, they spread and were in due time given legal sanction.

Such is the usual course of evolution in the formation of a system of weights and measures from a linear measure.

A modification of the original linear standard may lead to the evolution of a new system. Thus, when the Romans took as their foot $\frac{1}{5000}$ of a short mile of 8 Olympic stadia instead of $\frac{1}{6000}$ of the meridian mile of 10 stadia, this new foot was the starting point of a new system.

Another process of evolution, or rather of involution, may occur from an imported standard of capacity. Supposing that trade has carried a certain measure to

a country which it supplies with corn, and that this measure has been adopted, with divisions convenient to the people: from this corn-measure another measure, about $\frac{4}{5}$ of it, may be constructed, containing the same weight of wine or water that the former contains of corn; here will be a standard fluid measure, and perhaps some fraction of it filled with water may be taken as a standard of weight. Let now some cubical vessel be constructed to hold exactly the standard measure of water; the length or breadth of each side will give a linear unit which, if it approximate sufficiently with a foot or span to which the people are accustomed, will offer a fixed linear standard in harmony with the other standards. Thus, from a convenient foreign unit of capacity or of weight, a new and complete system of national measures may be constructed by involution.

It will be seen that several cases of such involution have happened. There is indeed no documentary evidence for them, and often very little for the more usual processes of evolution. But the evidence for the origin of most weights and measures is entirely circumstantial; it is by the study of metrology, founded on research into the systems of different countries, that the student is able to weigh circumstantial evidence, to use it prudently, to guard himself against mere coincidence, to clear away legend, to examine documentary evidence carefully, to read between the lines of records, often very deceptive if he come to them unprepared.

The various systems which have developed by these

processes, generally of evolution, but sometimes of involution, lose the appearance of Babel-confusion they had before their development could be explained otherwise than by fanciful legend or despotic caprice. But once the right point of view is found, unity is seen in the hitherto bewildering variety, and the trend of the human mind is seen to be regular in the systems that it evolves, in its way of meeting difficulties, in its acceptance of changes which are real improvements, in its aversion to arbitrary changes, in its devices for evading despotic interference with what it has found convenient.

CHAPTER II

THE STORY OF THE CUBITS

THE story of the cubits and of the talents, the great units of weight evolved from the cubits, is part of the history of the ancient and medieval Eastern Kingdoms, so intimately is it connected with their mutual relations, with their astrolatric ideas, and with the influence of those ideas on their science and art. This story, extending over more than fifty centuries, from long before the building of the Great Pyramid to near the tenth century of our era, explains the evolution of all weights and measures, ancient and modern.

The standard of the cubits has come down to us in great monuments, the measurements of which show undoubted unity of standard, and ancient histories and records often state the dimensions in the original cubits or in other cubits. Sometimes the actual wooden measures used by architects or masons are still extant; sometimes weights known to have been derived from these cubits either survive or can be ascertained. Thus in various ways the original length of the ancient cubits is known more accurately than that of many modern standards of length.

1. The Egyptian Common, or Olympic Cubit

A certain record of this cubit remains in the Great Pyramid. It is known to have measured 500 cubits along each side of the base, 2000 cubits or 500 fathoms being the perimeter of the base. The measurement made by our Ordnance Surveyors gave 760 feet for the side. The latest measurement, by Mr. Flinders Petrie, is not quite 6 inches longer. Taking the Ordnance Survey figure we have $\frac{760 \times 12}{500} = 18{\cdot}24$ inches as the length of the common cubit, and two-thirds of this gives 12·16 inches for the common foot, or the Olympic foot as it is called from the adoption of this standard by the Greeks.

This length, supported by measurements of other ancient monuments, may be regarded as certain. Four cubits or six Olympic feet were contained in the Egypto-Greek orgyia or fathom, and this measure = 72·96 inches or 6·08 feet, is exactly one-thousandth of the 6080 feet length of the Meridian or Nautical Mile.

This cubit, common to the three great ancient kingdoms, Babylonia, Egypt, and afterwards Assyria, originated probably in Chaldæa, passing to Egypt with the earliest civilisation of that country, and thence to Greece. The name of Olympic thence attached to this standard must not make us forget its origin. The saying of Sir Henry Maine, 'Except the blind forces of nature, nothing moves in the world which was not Greek in its origin,' is not exact unless we include as Greek the great kingdoms conquered by

Alexander, and which, under the Roman empire and afterwards under the Saracen caliphates, continued to have great influence over the civilisation of the West.

The Meridian Mile

At least sixty centuries ago the Chaldæan astronomers had divided the circumference of the earth, and of circles generally, into 360 degrees (that is 6×60) each of 60 parts. There is good reason to believe that they, before the Egyptians, who had the same scientific ideas, had already measured the terrestrial meridian and determined the length of the mean degree and of its sixtieth part, the meridian mile.

Owing to the flattening of the globe towards its poles, meridian degrees are not of equal lengths; they increase in length from the equator, so that their sixtieth parts are—

At degrees 1 to 3 = 68·704 statute miles; $\frac{1}{60}$ = 6046 ft.
„ 88 to 90 = 69·409 „ „ ; $\frac{1}{60}$ = 6108 ft.

The mean length is at about 49° N. where the degree and mile are—

69·091 statute miles; $\frac{1}{60}$ = 6080 feet.

The perimeter of the base of the Great Pyramid is exactly half of that length, i.e. 3040 feet.

The length of the meridian mile, 1000 Olympic fathoms = 4000 Olympic feet, was divided by the Greek geometers (and probably by the Egyptians and Chaldæans long before them) into 10 stadia, each of 100 fathoms = 600 Olympic feet = 608 feet, which is about our present cable length. And the meridian or

nautical mile, used by seamen of all nations, is this same Egypto-Greek mile of 6080 feet = $2026\frac{2}{3}$ yards = $1013\frac{1}{3}$ fathoms = 1·1515 statute miles. It is sometimes put at $6082\frac{2}{3}$ feet. French geometers estimate it at 1852·227 metres = $6076\frac{3}{4}$ feet, one ten-millionth of the quarter-meridian being = 1·0002 metre. The nautical mile is sometimes called a knot, in the sense of a ship going so many nautical miles in an hour, as ascertained by the number of knots of the log-line, each $\frac{1}{120}$ of a nautical mile or $50\frac{2}{3}$ feet, run out in half a minute, $\frac{1}{120}$ of an hour.

The meridian mile must not be confounded with the geographical or equatorial mile, $\frac{1}{60}$ degree along the equatorial circumference = $6087\frac{1}{3}$ feet.

Greek Itinerary Measures

Though a length of 10 stadia is a meridian mile, neither the Egyptians nor the Greeks appear to have used this mile as an itinerary measure. Herodotus says:

> All men who are short of land measure it by Fathoms; but those who are less short of it, by Stadia; and those who have much, by Parasangs; and such as have a very great extent, by Schoinoi. Now a Parasang is equal to 30 stadia, and each Schoinos, which is an Egyptian measure, is equal to 60 stadia.

The Parasang of 30 stadia was then 3 meridian miles, the modern marine league, $\frac{1}{20}$ of a degree.

The Schoinos was probably common to Egypt and to Chaldæa. The Chaldæans venerated the numbers 6, 60, 600, &c., and their sexagesimal scale, making the

year $6 \times 60 + 5$ days and the circle 6×60 degrees each of 60 minutes, has prevailed. The Olympic or Egyptian-Greek measures of distance were on this scale, though land-measures were, officially at least, on a decimal scale.

6 Olympic feet	= 1 fathom (orgyia)
60 ,, ,,	= 1 rod (kalamos)
60 rods or 600 feet	= 1 stadion
60 stadia (6 meridian miles)	= 1 schoinos
60 schoinoi	= 6 meridian degrees
60×6 degrees	= circumference of the globe.

Between the Stadion and the Schoinos there is a long gap, but the Greeks, for whose small country the Stadion was a convenient unit, used, when abroad, the Persian Parasang of 3 meridian miles, $= \frac{1}{7200}$ of the meridian circumference.

The rise of other cubits obscured the Olympic series of measures. The Schoinos became absorbed in the Parasang, and under the Roman domination it became a measure of 32 stadia or 4 Roman miles. The Stadion also came to vary; it was nearly always of 100 fathoms, but these might be fathoms of systems varying from the Olympic. The slightly different term Schoinion, meaning a rope or chain, was applied to a measure of 10 fathoms.

The Roman Mile

The Romans took for their itinerary unit a length of 8 Olympic stadia and, dividing it into 1000 paces or double steps, called it a mille (mille passus) or mile. The Roman mile and pace are therefore

respectively four-fifths of the meridian mile and the Olympic fathom—

$\frac{8}{10}$ of 6080 ft. = 4864 ft. = $1621\frac{1}{3}$ yards.

The pace was divided into 5 feet.

$\frac{1}{5}$ of 4·864 ft. (or 58·368 inches) = 11·673 inches.

There was in course of time some slight variation in the length of the Roman foot. It has been calculated at between 11·65 and 11·67 inches. The best value appears to be that of Greaves at 11·664 inches, but 11·67 seems to me sufficiently accurate, and corresponding better to other Roman measures.

The pace was also divided into quarters (palmipes) of a foot and a palm.

The foot was divided into 16 digits or into 12 inches (pollices). Roman dominion over Greece and Egypt led to some modifications, probably local, in measures of distance. There was a Roman schœnus of 4 miles, and the mile was divided, sometimes into 10 Olympic stadia, sometimes into 8 Pythic stadia of 500 feet or 100 paces.

It will be seen that the English mile was originally 5000 Roman feet, and then 5000 English feet, before being fixed at its present length of 5280 feet or 1760 yards.

2. The Egyptian Royal Cubit (*c.* 4000 b.c.)

The possession of a geodesic cubit, $\frac{1}{4}$ of the fathom which was $\frac{1}{1000}$ of the meridian mile, did not satisfy the astrolatric priesthood of Egypt. Under their

influence another cubit, of 7 palms = 20·64 inches, became the official measure of Egypt, and it was used in the planning of the monuments, always excepting the outside plan of the Great Pyramid.

What could have been the reason for this change, from the scientifically excellent and fairly convenient common cubit to this less convenient length, and for bringing the inconvenient number seven into the divisions and making both palms and digits different in length from those of the common cubit?

No valid reason can be found other than the desire to institute, by the side of the common cubit in which the 6 palms and 24 digits corresponded to the watches and hours of the day, a sacred cubit in which the 7 palms would correspond to the seven planets or to the week of seven days, and the 28 digits to the vulgar lunar month of four weeks of seven days.[1] Among us, at the present day, astrology is far from being dead; the days still bear the names of the seven planets ruling successively the first hour of the days named respectively after them; we call, however unconsciously, men's temperaments or characters according to the mercurial, jovial, saturnine and other influences of the planets which rule the hour of birth. It is not for us then to criticise severely the pious desire of a learned priesthood or of a theocratic king to institute a sacred standard of linear measure with divisions corresponding in number to the seven planets which

[1] Plutarch speaks of the mystic connexion assumed by the Egyptians between the 28 cubits maximum rise of the Nile and the same number of days in the lunar month.

ruled the destinies of man, whose influence ruled them through the Christian middle ages, which at the present day still rule the world in the minds of the great majority of mankind. The royal or sacred cubit became the official cubit of the Eastern great kingdoms, the common or meridian cubit being also used, not only for ordinary purposes, but sometimes along with it. Thus, the external dimensions of the Great Pyramid are in common cubits, while the unit of its internal dimensions is the royal cubit, perhaps recently established at the time of the building.[1] And centuries after the institution of the royal cubit, the meridian cubit became the standard of the Greeks.

The question naturally arises—Why was the royal cubit not formed by simply adding a seventh palm to the common cubit, a palm of the same length, $= 3{\cdot}04$ inches, as the six others? This would have given a new cubit of $18{\cdot}24 \times \frac{7}{6} = 21{\cdot}28$ inches, instead of $20{\cdot}64$ inches in 7 palms of $2{\cdot}95$ inches. And it will be seen that this was actually done, fifty centuries later, by the caliph Al-Mamūn.

The answer I venture to give is, that the royal cubit was intended to be, not only by its division a homage to the seven planets, but also, by its increase of length, a symbol of the proportion of latitude to longitude at some Egyptian observatory.

[1] The royal cubit is sometimes called the Philiterian cubit; this name (apparently meaning 'royal') is used by the later Hero of Alexandria, who wrote about 430. But Herodotus says, 'They call the pyramids after a herdsman Philition who at that time grazed his herds about that place'; so it is probable that the name came from some legend.

Possibly it was a practical commemoration of the art of determining longitude. On this hypothesis the new cubit was made as much longer than the old cubit as the mean degree of latitude is longer than the degree of longitude in 29° N., at an observatory about 50 meridian miles south of the Pyramids. In that parallel, the proportion of the degree of longitude to the degree of latitude is 1 : 1·13, or as 18·24 to 20·64.

Measurements of monuments, both in Egypt and in the Babylonian and Assyrian Kingdoms, show that 20·64 inches was the length of the royal cubit, and actual cubit measures now extant do not vary from it more than one- or two-hundredths of an inch. There are at least ten of these cubits in museums and in other collections. One, a double cubit, is in the British Museum; another, very perfect, is in the Louvre; another, of rough graduation, but accurate length, is in the Liverpool Museum. There may be others, generally unknown. I found one, apparently unrecorded, in the museum of Avignon.

As the Pyramids are very nearly in the same parallel of latitude as the southern limits of Babylonia, near Ur of the Chaldees, it is possible that the length of the royal or sacred cubit may have been as acceptable to the priesthood of Babylonia as that of Egypt. This would account for the prevalence of the seven-palm cubit throughout the Eastern great monarchies. Perhaps the new cubit may have been instituted internationally between the Bureau des Longitudes of Egypt and that of Babylonia.

As in the case of the common cubit, two-thirds of the royal cubit were taken for the royal foot = 13·76 inches, a measure which when cubed will be seen to be the source of our Imperial system of weights and measures.

The inconvenience of a cubit of 7 palms is increased when two-thirds of it are taken for the foot; this foot, being $4\frac{2}{3}$ palms or $18\frac{2}{3}$ digits, was possibly divided for popular use into 16 digits, if it were ever in popular use. For scientific and probably for popular use it appears to have been divided into 2 feet = 10·32 inches. This may be inferred from the division of the degrees, attributed to Eratosthenes (third century B.C.), into 700 stadia, each 600 of these feet. Probably 700 is a round number, for, on the basis of this foot, the degree would be 706·8 stadia.

Three centuries later Pliny gave the base of the Great Pyramid a length of 883 feet. The modern measurement being 760 feet = 9120 inches, we have $\frac{9120}{883} = 10{\cdot}328$ as the length of the foot in Pliny's account, a length differing by less than $\frac{1}{100}$ inch from that of the half-cubit.

The investigations of Fréret, Jomard, Letronne and other mathematicians led them to the conclusion that the ancient Egyptians had surveyed their land so exactly as to know its dimensions to a cubit near, and that certainly at some unknown time they had measured an arc of the meridian and established their measures on the basis of the meridian degree with no less exactness than has been done in modern times.

I have put aside all attempts, often connected with

theology, to show that the base of the Great Pyramid was 220 double cubits (of 2 × 20·61 inches), the same number as the yards in an Elizabethan furlong, or that its other dimensions were intended to hand down the English inch, or the gallon, or the squaring of the circle, or the laws of harmonic progression.

3. The Great Assyrian or Persian Cubit (c. 700 B.C.)

The Egyptian idea of increasing the cubit appears to have also seized the Assyrian monarchy many centuries later. It was increased to 8 palms, as different from those of the Egyptian royal cubit as these were from those of the meridian cubit.

18·24	Egyptian common	cubit	6	palms	of 3·08 in...	24 digits
20·64	,, royal	,,	7	,,	of 2·95 in...	28 ,,
25·26	Assyrian	,,	8	,,	of 3·16 in...	32 ,,

This new measure is the cubit of Ezekiel, the 'great cubit,' the 'cubit and a handbreadth,' = 25·26 inches.

The same question as that presented by the increased cubit of Egypt arises in the case of the Assyrian cubit. What reason can be suggested for an increase such as to again disturb the palm and the digit? The advantage of having a standard of 8 palms divisible into 2 feet of 4 palms, could have been obtained far more simply and conveniently by adding an eighth palm equal to the others, making it 23·6 inches, with a half giving a foot = 11·8 inches. Or two palms might have been added to the common cubit, making

a new cubit = 24·32 inches, with the Olympic foot as its half.

I again venture a similar explanation. The increase from the length of the Egyptian royal cubit corresponds to the ratio of the degree of longitude to the degree of latitude in 35·5° N., i.e. 1 : 1·224—

$$1 : 1{\cdot}224 :: 20{\cdot}64 : 25{\cdot}26.$$

This position was only 30 meridian miles from the parallel of 36° N., a line which, passing through Rhodes and Malta to the Straits of Gibraltar, was considered by the ancient geographers as the first parallel and was the base-line of their maps. It was called by the Greek geographers the 'diaphragm of the world.'[1]

This line passing also a few miles south of Nineveh, it is possible that some observatory near that capital city, a few miles south of 36°, may have been the point at which the difference in the lengths of the degrees of longitude and of latitude was determined for the standard length of the new cubit.

There is an alternate hypothesis. The Egyptian royal cubit was increased by 1·224 to make the Great Assyrian cubit. Now this is about the proportion in which a measure containing a certain weight of water must be increased in height to contain the same weight of wheat. This proportion, the water-wheat ratio, is something between 1·22 and 1·25, the former being the usual ratio with the heavier wheat of Southern countries. Supposing a cubical vessel measuring a

[1] Διάφραγμα τῆς οἰκουμένης. Instituted by Dicæarchus 310 B.C., corrected by Eratosthenes 276–196.

royal cubit of 20·64 inches in each side, therefore containing 8792 cubic inches = 317 lb. of water (which was the Great Artaba) to be increased in height so as to hold the same weight of wheat, its height would now be $1{\cdot}224 \times 20{\cdot}64 = 25{\cdot}26$ inches. This might have been taken for a new cubit.

This would not prevent the new cubit, the Great Assyrian cubit, being itself in course of time cubed to form the Den measure, as its half, the foot, was cubed for its weight of water to make the Greek-Asiatic talent.

However this be, the great Assyrian cubit, which continued to be used in the Persian empire, had the advantage of being divided into 8 palms and of making a good two-foot rule, though its half, the foot, was rather too long for popular use. This cubit exists to this day in Egypt, being the basis of the Reed or Qasáb. This is the 'full reed of six great cubits' (Ezek. xli.), the 'measuring rod of six cubits by the cubit and a handbreadth,' that is the old seven-palm cubit with a palm added. The Qasáb = 151·16 inches is = 12 Assyrian feet.

Yet, for the common purposes of life, a foot = 12·63 inches was too long to be popular; everywhere the people like a short foot, especially in the South and the East. Moreover the cubit was a departure from the simple geodesic standard of the meridian cubit. Accordingly there was devised in Persia a cubit satisfactory both to the scientific class and to the people, with a simple geodesic standard for scientific purposes and a convenient short foot for the common purposes

of life. This was the Beládi cubit. It is perhaps the best of the cubits.

4. The Beládi Cubit (*c.* 300 B.C.)

The new Persian cubit, known as the Beládi (from *belád*, country), had the advantage, first, of a simple relation to the Parasang or meridian league of 30 stadia = $\frac{1}{20}$ degree; secondly, of it being divisible into two feet of convenient length.

The meridian mile being = 6080 feet or 72,960 inches the parasang is therefore 3 × 72,960 = 218,880 inches; and the Beládi cubit, $\frac{1}{10000}$ of the parasang, was therefore = 21·880 inches. This is the length that John Greaves gave in 1645 as his measurement of what he called the Cairo cubit, one of the different standards that have accumulated in Egypt during sixty centuries.

The Beládi cubit is still to be found in the East. A half Beládi cubit = 10·944 inches, a convenient foot for Eastern use, passed to Spain with the Moors and became the Burgos foot, the standard of which was allowed to go astray after the fall of the Moorish dominion. But the Spanish shore-cubit (*Covado di ribera*) still exists at the standard of 21·9157 inches.

The Beládi cubit is that used by Posidonius (131–53 B.C.). He gave the circumference of the globe as 240,000 stadia, which = 666·66 to the degree, or 11·111 to the meridian mile of 6080 feet or 72,960 inches, $\frac{72{,}960}{11{\cdot}111}$ = 6566 inches or 10 fathoms of 65·66465 inches, exactly 3 Beládi cubits or 6 half-cubits.

It is interesting to find this Greek philosopher,

settled in Rome, reckoning the circumference of the globe accurately on the basis of the Belâdi cubit of Persia. Coupling this with the use by the Hebrews of the Bereh equatorial cubit brought back from the Captivity, the date of the Belâdi meridional cubit is evidently at some centuries before the Christian era.

The Bereh or Equatorial Land-mile.

The Jews brought back from the Captivity a measure known as the Cubit of the Talmud. It was $\frac{1}{3000}$ of a mile, called the Bereh, which was said to be $\frac{1}{24000}$ of the circumference of the earth. Now this latter fraction corresponds to one-thousandth of an hour of longitude, or of 15 degrees on the equator, and thus points to the Bereh being an equatorial, not a meridian mile. It is still extant in the Turkish dominions in Asia. While the modern, as the ancient, Persian Parasang is $\frac{1}{7200}$ of the meridian, the Turkish Farsang of 3 Bereh should be $\frac{3}{24000} = \frac{1}{8000}$ of the equatorial circumference—

$$\tfrac{1}{8000} \text{ of } 2029{\cdot}11 \text{ yards} \times 60 \times 360 = 5478{\cdot}6 \text{ yards.}$$

This corresponds very closely to the length of the farsang, which is 5483·9 yards. The Bereh, by calculation, is 1826 yards and the Talmudic cubit, $\frac{1}{3000}$ of it, = 21·914 inches.

Each then was one 72-millionth of the terrestrial circumference, but the Talmudic cubit was measured on the equator, the Belâdi cubit on the meridian.

Talmudic cubit	$\frac{1}{10000}$	of a league		$\frac{1}{7200}$	of the	equator.
Belâdi	,,	$\frac{1}{9000}$	,,	,,	$\frac{1}{8000}$,,	meridian.

5. The Black Cubit (Ninth Century)

Many centuries after the institution of the Assyrian great cubit and of the Persian Belâdi cubit, another important cubit became a standard of measure in the Moslem caliphate which reigned over the lands of the Eastern great kingdoms.

Under Al-Mamūn, son of Harūn al-Rashid, science was flourishing in the East, while the West was in the dark ages, at least in all the countries unenlightened by the civilisation of the Moors of Spain. Of Christian Europe, Provence and the other Occitanian countries alone had that light, a light that shone over other countries until extinguished by the Albigensian crusade.

'Mahmd Ibn Mesoud says that in the time of Almamon (the learned Calife of Babylon) by the elevation of the pole of the equator, they measured the quantity of the degree upon the globe of the earth, and found it to be $56\frac{2}{3}$ miles, every mile containing 4000 cubits, and each cubit 24 digits, and every digit 6 barleycorns, and every barleycorn 6 hairs of a camel' ('A Discourse of the Romane Foot and Denarius,' by John Greaves, Professor of Astronomy in the University of Oxford, 1647).

From this determination of $56\frac{2}{3}$ meridian miles to the degree of longitude it would appear, (1) that the measurement was made at about 20·1°; south of Mecca, (2) that the meridian mile was still of 4000 Egyptian common cubits or 1000 Egyptian fathoms.

It was then probably after this measurement that Al-Mamūn instituted his new Cubit, sometimes known

as the Black cubit, so named from the black banner and dress adopted by the Abbaside caliphs.

This new cubit was not, directly at least, of geodesic basis. The caliph was probably inspired by the idea of making in a reasonable manner the alteration which the ancient Egyptians had done badly in making their seven-palm cubit out of simple proportion to the common cubit. So the new cubit had palms and digits of the same length as the common cubit. But it had all the inconveniences of the factor seven. Perhaps Al-Mamūn may have thought that the addition of a seventh palm was not only a homage to the seven planets but that it was satisfactory to lengthen the common cubit in the ratio of the degree of latitude to that of longitude in a part of his dominions where the ratio was exactly 7 to 6. This is the ratio at Alexandria, in 31° N.

The Common cubit being = 18·24 inches = 6 × 3·04 in.
The Black cubit was = 21·28 ,, = 7 × 3·04 in.

Two-thirds of this cubit were taken for

The Black foot = 14·186 inches, divided into 16 digits of the 24 digits or qiráts of the cubit.

This cubit and foot are still in use. The old nilometer on the island of Al-Rauzah (Rode) near Cairo has its scale in cubits of this standard, and measurement of the worn scale gives 21·29 inches for the cubit.

The cubit and foot of Al-Mamūn are the basis of measures and of weights which spread from Egypt to every country in Europe.

The story of the five cubits, ancient and medieval,

has shown that they were all derived, directly or indirectly, from the meridian measurement of the earth, some of them being probably instituted with the desire to make them representative of the relation of latitude and longitude.

I venture to say that every measure and weight used throughout the world has been developed from one of these cubits and thus, more or less directly, from the Egyptian meridian cubit. The Republican system of France is but a decimal imitation of the system based on the common Egyptian meridian cubit; its basis being the kilometre, $\frac{1}{10000}$ of the quarter-meridian, instead of the Egyptian meridian mile, $\frac{1}{90 \times 60}$ of the quarter-meridian.

There were some other cubits of minor importance; one of them is the Hashími cubit described in Chapter XVII.

Comparative Lengths of the Five Ancient Cubits

Egyptian common cubit	= 18·24	in.;	its foot	$\frac{2}{3}$	= 12·16	in.
„ royal „	= 20·64	„	„	$\frac{2}{3}$	= 13·76	„
Great Assyrian „	= 25·26	„	„	$\frac{1}{2}$	= 12·63	„
Beládi „	= 21·888	„	„	$\frac{1}{2}$	= 10·944	„
Black „	= 20·28	„	„	$\frac{2}{3}$	= 14·186	„

CHAPTER III

THE STORY OF THE TALENTS

IT has been seen that throughout the ancient Eastern Kingdoms, from soon after 5000 B.C. to some centuries after our era, there was general unity in the system of linear measures. It will now be seen that there was similar unity in the system of weights and measures, all derived from some well-known linear standard cubed. In modern times this unity is much less apparent, but yet it can be traced, and it survives with little change in the great part of the world where the English system of weights and measures remains as an inheritance from the most ancient epochs of civilisation.

The 400 shekels of silver, currency of the merchants, that Abraham weighed to Ephron about 1900 years B.C. were probably of about the same weight as 400 half-crowns of the present day.

When Moses levied 100 talents and 1775 shekels, at the rate of half a shekel on each of the 603,550 men who were numbered (Exod. xxxviii.), the weight of the silver shekels can be precisely ascertained.

$\frac{603550}{2}$ = 301,775 shekels = 100 talents and 1775 shekels.

The Talent was the weight of an Egyptian royal cubic foot of water and was divided into 3000 shekels.

The royal foot, $\frac{2}{3}$ of the cubit, = 13·76 inches.

The foot cubed = 2605 cubic inches; $\frac{2605}{27{\cdot}73} =$ 93·9 lb. as the calculated weight of the standard afterwards known as the Alexandrian talent.[1]

The actual weight was 93·65 lb. = 655·550 grains; $\frac{655550}{3000}$ = 218·5 grains was the weight of the shekel, nearly our half-ounce—exactly the half-ounce of Plantagenet times, and very near to the weight of our half-crown, which weighs 218·18 grains.

The difference between calculated weight and the actual weight determined from coin or other standards, from trustworthy historical statements and other sources of information or of evidence, is generally due to the great difficulty in constructing accurately the cubical vessel used to ascertain the weight of a cubed measure of water. A difference of $\frac{2}{100}$ of an inch in the sides of the vessel made to hold a royal cubic foot of water would make a difference of about 3 parts in 1000, of $4\frac{1}{2}$ of the 1500 ounces or double-shekels of water it contained. And we do not know the temperature of the water used.

From the ancient and medieval cubits were derived all the weights and measures of medieval and modern civilisation, largely through the medium of the talents derived from these standards.

From the Egyptian	common foot	came the	Olympic Talent
,, ,,	,, royal	,, ,, ,,	Alexandrian ,,
,, ,,	Great Assyrian	,, ,, ,,	Greek-Asiatic ,,
,, ,,	Arabic	,, ,, ,,	Arabic ,,

[1] The Imperial pound = 27·727 cubic inches of water, 7000 grains: the gallon 10 lb. or 277·274 c.i.

1. The Alexandrian Talent

The standard of this talent has been already given as 93·65 lb., which × 7000 = 655,550 grains.

It was divided on different systems:

1. By the Chaldæans and Egyptians into 60 minás, divided—
   (*a*) On the Chaldæan system into 60 shekels of 182 grains, with a quarter-shekel = 45½ grains.
   (*b*) On the Phœnician, and Hebrew, system into 50 shekels of 218½ grains, with a quarter-shekel = 54·6 grains.
2. By the Greek-Egyptians into 120 minás (or the half or lesser talent into 60 minás) of 100 drachmæ = 54·6 grains.
3. By the Romans into 125 libræ of 12 unciæ (1500 ounces) further divided by the Greeks into 8 drachmæ = 54·6 grains.

Three of these modes of division give a drachma of 54·6 grains. So a Phœnician or Hebrew shekel, a Ptolemaïc tetradrachm and a Roman half-ounce, are of the same weight, differing by only ¼ grain from our half-ounce, and by only ½ grain from our half-crown.

The Alexandrian talent was the Hebrew Kikkar or talent of the sanctuary. In the Chaldæan kingdom the standard measure was the Egyptian royal cubit, and the standard weight was the talent derived from its foot; but the miná appears to have been divided into 60 instead of 50 shekels.

The words which Belshazzar saw written on the wall referred to the miná and shekel, or tekel, of this talent. Their meaning may be thus rendered :

Mene, a miná—the great King Nabupalasur, founder of the new Chaldæan Kingdom.

Mene, a miná—the great King Nabukudurusur, son of the preceding.

Tekel, a shekel (of 4 quarters)—Nabunahid (Belshazzar) and his three predecessors, all of small account.

Upharsin, a division, perhaps 2 half-shekels, the Medes and Persians. Or it may simply be the Parsīs or Persians, the enemies at the gate.

This talent is still extant at Bássora (in Chaldæa) as the *mánd sofi* = 93·22 lb.

The Medimnos.

This was the measure made to hold an Alexandrian talent of wheat. The cubed Egyptian royal foot (probably used as a fluid measure) was increased in the Southern water-wheat ratio of 1 : 1·22. Thus 2605 c.i. $\times$ 1·22 = 3176 c.i. and $\frac{3176}{277 \cdot 4} = 11 \cdot 45$ gallons as the contents of the Medimnos.

This measure was adopted by the Romans, as well as by the Greeks, as the basis of their corn-measures, doubtless in consequence of the corn-trade from Egypt. A sixth part of it was the Roman Modius.

The Medimnos was divided by the Greeks into 48 Choinix, or into 96 Xestes (L. *sextarius*) = 0·95 Imperial pint or 19 fluid ounces.

2. The Lesser Alexandrian or Ptolemaic Talent

This was half of the ordinary or greater talent.

Half the calculated weight of the greater talent gives 46·956 lb. for the lesser. But the actual weight was somewhat less, 46·82 lb.

It was divided into 60 Ptolemaïc miná = 5462 grains, and the miná into 100 drachms. The drachm = 54·62 grains and the tetradrachm = 218·5 grains coincide as coin-weights with the quarter-shekel and shekel of the greater talent.

The miná was divided also on the Roman uncial system :

1/12 = an ounce = 455·28 grs. ; of this
1/12 = a double-scruple = 37·94 grs. ; of this
1/12 = a carat of 3·1616 grs.

The carat $\frac{1}{144}$ ounce, is exactly, to $\frac{1}{100}$ grain, the jeweller's carat of to-day in European countries.

What could be the reason for this talent ?

Its miná was half an Alexandrian miná ; its drachm was a quarter-shekel.

Don V. V. Queipo [1] considered that the half Beládi cubit had been produced from it by involution, taking the side of a cubical vessel containing half an Alexandrian talent of water and then doubling this new foot to make a new cubit. Its water-volume = 1302·5 c.i. gives as cube root 10·9207 inches, almost exactly half the Beládi cubit = 21·888 inches. But the Beládi cubit being $\frac{1}{7200}$ of a Parasang is sufficient evidence of its

[1] *Essai sur les Systèmes Métriques* (1859).

origin. I consider that the close coincidence of the half-cubit with the side of a cubic vessel containing an Alexandrian half-talent of water led the Ptolemies to institute this smaller talent, as if it had been evolved from the Belâdi foot in the same way that the Greek-Asiatic talent had been evolved from the Persian foot or half-cubit.

3. The Greek-Asiatic Talent

After the institution of the great Assyrian or Persian cubit a new talent was necessarily evolved from it.

The Persian foot, half of the cubit, was cubed, and the weight of this cubic foot of water was the Persian or Greek-Asiatic talent—

$$\frac{25{\cdot}26}{2} = 12{\cdot}63 \text{ inches}; \quad 12{\cdot}63^3 = 2014 \text{ c.i.} = 72{\cdot}61 \text{ lb.}$$

The actual weight of this talent (as in the case of the Alexandrian talent) was somewhat less. It corresponded to a cubic foot of 2000 c.i., giving 72·13 lb. = 504,910 grains. This was divided into 60 minâs—

$$\frac{72{\cdot}13 \text{ lb.} \times 1000}{60} = 8415 \text{ grains} = 1{\cdot}2 \text{ lb.}$$

The minâ was divided by the Persians into 100 darics = 84·15 grains. The actual weight of silver darics found, 83·73 grains, corresponds almost exactly to this weight.

This is the talent Herodotus used when estimating the revenue of the Persian empire. Its miná has survived as the Attári or Assyrian rotl = 8426 grains, extant in Algeria. Another Attári pound = 8320 grains is still used at Bássora, near the Persian gulf. The ounce of this rotl, $\frac{8426}{16} = 526{\cdot}6$ grains, is exactly the Russian ounce.

The Persian coins weighing 129–130 grains usually called darics are staters or Greek didrachms.

The Metretes

The second Greek standard of capacity was the Metretes.

While the Medimnos contained an Alexandrian talent of wheat, the Metretes contained a Greek-Asiatic talent of it.

The capacity of the Persian cubic foot was 2000 c.i. = 72·13 lb. = 7·213 gallons.

This cubic foot, increased in water-wheat ratio, gives $7{\cdot}213 \times 1{\cdot}22 = 8{\cdot}8$ gallons or 70·4 pints, as the capacity of the Amphoreus metretes.[1]

Some archæologists have given it as = 8·68 gallons, a very slight difference.

The Metretes was divided into 36 Choinix or 72 Xestes, which contained 0·977 pint as against the 0·955 pint of the Xestes, which was $\frac{1}{96}$ Medimnos. A mean

[1] The Metretes was one-tenth more than our firkin. In the story of the Marriage at Cana (John ii.) the Greek has 'two or three metretes.' This term is kept in Wycliff's version (1388) and in the modern Dutch version.

figure, 0·96 pint, is usually taken as the common capacity of the two Xestes.

The Greeks had thus two standards of capacity, the Metretes and the Medimnos, both cubic feet increased in water-wheat ratio to make them corn-measures. It is very likely that, having these two measures from different sources, the one of 72 Xestes, the other of 96, they would use the smaller as a fluid measure. In modern measures there are several instances of corn-measures having become wine-measures. Our Imperial gallon used for fluids is a slightly altered corn-gallon; at present the multiples above the gallon are used for corn, the gallon and its divisions for fluids.

4. Roman Weights and Measures of Capacity

Used by the Greek colonies in Asia, the Greek-Asiatic talent passed to the Greek or Trojan colonies in South Italy, and became the source of the old Roman pound, the *As libralis* = 5049 grains, $\frac{1}{100}$ of the talent;

$$\frac{72{\cdot}13 \times 7000}{100} = 5049 \text{ grains.}[1]$$

The Aes or As, the bronze or copper pound of the Roman republic in its earlier times, was divided into 12 ounces, each = 420·75 grains.

It remained the mint-pound of both Republic and Empire.

The Aurei of Julius Caesar, $\frac{1}{40}$ As, weigh 127 grains, those of Augustus 125 grains. The mean weight

[1] 5050 grs.—Smith's *Dict. of Antiquities*. 5047 grs.—Daremberg and Scaglio's *Dict. of Antiquities*.

appears to be about 126 grains, which gives 5040 grains for the As.

The Aurei of the later Empire were struck at $\frac{1}{72}$ As, and weigh 70 grains, giving the same weight, 5040 grains, for the As. At 70·1 grains they would give 5049 grains, the calculated weight of the As.

The evolution of the As from the Greek-Asiatic talent leads to consideration of the measures connected with it, and with the Alexandrian talent.

It has been seen that the Roman foot, $\frac{1}{5000}$ of the Roman mile, 8 Olympic stadia, was 11·67 inches. This foot being cubed, the weight of the cubic foot of water was made the basis of the Roman measures of capacity—

$$11{\cdot}67^3 \text{ inches} = 1589 \text{ c.i.} = 57{\cdot}32 \text{ lb. water}$$
$$= 401{,}240 \text{ grains.}$$

This calculated measure, 57·32 lb. = 5·732 gallons = 45·8 pints, was the Amphora Quadrantal, supposed to weigh, of wine, 80 As or primitive pounds. *Quadrantal vinei octoginta pondo sit.* The correspondence was only approximate. The Quadrantal should have been = 57·7 lb. for its $\frac{1}{80}$ part (= 5049 grains) to correspond with the As. Its capacity was probably adjusted so as to make it half a Medimnos and = 3 Modii.

There are specimens extant of the Quadrantal, of cubical shape, showing that it was named from its being a cubic foot in measure.

The Quadrantal, being equal to 45·8 pints, was

almost exactly half the Greek Medimnos, equal to 91·5 pints; so that, divided into 8 congii, each of 6 sextarii, the Sextarius, $\frac{1}{48}$ Quadrantal, was practically the same as the Xestes, $\frac{1}{96}$ of the Medimnos.

And the Quadrantal being also very nearly two-thirds of the Greek Metretes, equal to 70·4 pints, the Sextarius was also nearly the same as the other Xestes, $\frac{1}{72}$ of the Metretes.

So the Sextarius was $\frac{1}{48}$ Quadrantal, $\frac{1}{72}$ Metretes, and $\frac{1}{96}$ Medimnos.

The relation of the Roman Modius to the Alexandrian-Greek medimnos appears to be only a coincidence, as the former is one-third of a Roman cubic foot, and the latter an Alexandrian cubic foot increased in water-wheat ratio.

The New Roman Pound

Trade with Egypt led the Romans, not only to use the Alexandrian medimnos, but also to put aside the As for commercial purposes and adopt a standard taken from the Alexandrian talent. Its 1500 double-shekels made 125 libræ each of 12 unciæ = 437 grains. The libra was thus = 5244 grains as compared with the As = 5049 grains.

A further uncial division of the libra made the Uncia either of 6 sextulæ, 24 scrupuli, 48 oboli, 144 siliquæ, or of 12 semi-sextulæ, 144 siliquæ.

The siliqua was a little less than the Eastern qirát, being 3·03 grains instead of the 3·1616 grain carat of the Ptolemaïc series of weights.

Table of Roman Weights and Measures of Capacity

Weights

OLD WEIGHTS (MINT SERIES)			NEW WEIGHTS (MEDICINAL SERIES)	
As = 5040 grs.	12	unciæ	Libra	= 5244 grs.
Deunx	11	,,	Uncia	= 437 ,,
Dextans	10	,,	Sextula	= 72·8 ,,
				= $\frac{1}{6}$ uncia
Dodrans	9	,,	Denarius	= 62·45 grs.
				= $\frac{1}{7}$ uncia
Bessis	8	,,	Drachma	= 54·6 grs.
				= $\frac{1}{8}$ uncia
Septunx	7	,,	Scrupulus	= 18·2 grs.
				= $\frac{1}{3}$ drachma
Semissis	6	,,	Obolus	= 9·1 grs.
Quincunx	5	,,	Siliqua	= 3·03 ,,
Triens	4	,,	Chalcus	= 1 ,,
				= $\frac{1}{3}$ siliqua
Quadrans	3	,,	Lens (Sitarion)	= $\frac{3}{4}$ gr.
				= $\frac{1}{4}$ siliqua
Sextans	2	,,		
Uncia = 420 grs.	1	,,		

Measures

WINE			CORN	
Metretes (Gr.)		= 8·8 gall.	Medimnos	= 11·45 gall.
Quadrantal	80 As	= 5·77 ,,		= 2 quadrantal
Urna	40 ,,		Modius	= 1·92 gall.
				= $\frac{1}{3}$ quadrantal
Congius	10 ,,	= 5·77 pints		
Sextarius	20 unciæ	= 0·96 ,,		
Hemina	8 ,,			
Acetabulum	2 ,,			
Cyathus	1 ,,			
Ligula	$\frac{1}{4}$,,			

5. The Olympic Talent

From the Olympic foot, two-thirds of that most ancient linear standard the common cubit of Egypt and the other Eastern monarchies, a talent was also constructed—

$$12{\cdot}16^3 \text{ in.} = 1798 \text{ c.i.} = 64{\cdot}81 \text{ lb. water} = 453{,}670 \text{ grs.}$$

and in practice its actual weight was the same as that calculated.

It was divided in two ways:

1. On the Bosphoric system, which prevailed in Asia Minor, in the Phœnician colonies, and in some parts of Greece, it was divided into 80 miná, each = 5670 grains, and these into 100 drachms of 56·7 grains. Or the Bosphoric miná was divided uncially into 12 ounces of 472·5 grains.

2. On the Euboic system, frequently used in Greek commerce, this talent was divided into 50 minás of 100 drachms.

The drachm = 90·73 grains.

There was also a Euboic talent which coincided with the weight of the Roman Quadrantal, nominally of 80 As weight = 57·7 lb., and in transactions with the East the Romans appear to have called their Quadrantal-weight of water a Euboic talent. But it will presently be seen that this was the Attic monetary talent.

The volume of an Olympic talent of water was 8 times the Hebrew Bath or, for dry goods, Epha.

COMPARISON OF OLYMPIC AND IMPERIAL MEASURES

	OLYMPIC	IMPERIAL	
Foot	= 12·16 in.	12 in.	
Cubic foot	= 1798 c. in.	1728 c. in.	
Talent	= 64·81 lb.	62·3 lb.	
$\frac{1}{1000}$ of talent	= 453·6 grs.	437·5 grs.	
$\frac{1}{8}$ = Bath	= 8·1 lb. water	Orig. Wine gallon	7·83 lb.
		Modern ,, ,,	8·33 ,,
		Imperial ,, ,,	10 ,,

6. GREEK COIN-WEIGHTS

In ancient Greece as in medieval Europe, financial difficulties led rulers to lower the weight of the coinage. But while in Europe, in England for instance, more pennies were coined from the mint-pound of silver, this remaining fixed, although nominally based on the weight of the sterling, the weights of Greece were actually based on that of the drachma.

When the drachma was diminished in weight, the miná and the talent both dropped proportionately. Thus the standard of the Alexandrian talent, carefully preserved in Egypt, dropped in Greece.

	Drachma	Miná of 100 drachmæ	Talent of 60 miná
Egypt	109¼ grs.	10,926 grs.	93·65 lb.
Ægina, early	105 ,,	10,560 ,,	90·5 ,,
,, before 700	103·7 ,,	10,370 ,,	88·9 ,,
,, after 700	95·68 ,,	9,568 ,,	81·76 ,,
Athens, 600 B.C.	93·08 ,,	9,308 ,,	79·78 ,,

So in Athens, where the Ægina standard was in use, the drachma stood at 93·08 grains when, in 594 B.C.,

Solon's Seisachthia law 'unburdened' the State and other debtors by decreeing that 73 (or more accurately $72\frac{1}{2}$) drachmæ should now be equal to 100 drachmæ, and altering the coinage accordingly.

This reduced the coin-weights of Athens to—

Drachma	Didrachma	Miná	Talent
67·37 grs.	125·74 grs.	6737 grs.	57·75 lb.

But commercial weight remained the same. The miná emporikí, the trade miná, was fixed at 138 of the new drachmæ, so that it continued to be 100 of the old drachmæ: $138 \times 67{\cdot}37 = 100 \times 93{\cdot}08$ grains.

The commercial miná thus remained at the 600 B.C. standard of 9308 grains = 1·33 lb. and the talent at 79·78 lb.[1]

In settling the reduction of the Attic money-weight at 100 new drachmæ = 73 old drachmæ, Solon probably fixed on the latter figure in order to make the new talent, = 57·74 lb., have approximately the simple ratio of 4 : 5 with the Greek-Asiatic talent—

$$\tfrac{4}{5} \times 72{\cdot}13 \text{ lb.} = 57{\cdot}704 \text{ lb.}$$

Thus the Roman As being = 5049 grains, $\frac{1}{100}$ of the Greek-Asiatic talent, 80 As, = 403,920 grains = 57·7 lb., came to coincide with the Attic monetary talent.

7. The Arabic Talent

To the talents and measures of capacity evolved

[1] There was a custom of *rhōpi*, turn of the scale, or long weight, which increased the legal commercial weight to a customary weight tending towards that of the Alexandrian talent series.

from the feet of the three principal cubits of antiquity, must be added the talent and other measures evolved from the Black foot of Al-Mamūn's cubit. They have had great influence on the weights and measures of Europe.

Al-Mamūn's cubit was = 21·28 inches, the foot = 14·186 inches.

The foot cubed gave a measure of water, the weight of which was the Egyptian Cantar or Cental—

$$14{\cdot}186^3 = 2855 \text{ c.i.} = 102{\cdot}92 \text{ lb. water} = 720{,}441 \text{ grs.}$$

This talent was divided in two ways:

1. As the Romans had divided the Alexandrian talent into 125 pounds of 12 ounces, so the new talent was divided into 125 parts each = 5763 grains. This was the Arabic lesser Rotl, its ounce = 480·25 grains. The rotl was also divided in the Greek way into 100 drachms or dirhems = 57·63 grains.

2. Another mode of division was into 100 greater Rotl, thus becoming a Cental of 100 lb. each = 7204·4 grains.

This greater rotl was divided, commercially into 16 ounces (Ar. *ukyé*, Gr. *oggia*, L. *uncia*) of 450,275 grains, and uncially for coin-weight into 12 × 12 dirhems of 50·03 grains.

Both these dirhems became, like the drachma coin-weights of Greece, the bases of other systems of weight, either at their original weight or at the lower weights to which coins might fall.

The Lesser Rotl—

1. With its ounce of 480¼ grains would seem to

have given rise to the Troy pounds, but it is much more probable that their variable ounces were 10 dirhems of about 48 grains.

2. From 8 of its drachms came the Venetian pound and the German apothecaries' pound with an ounce of $8 \times 57{\cdot}63 = 461$ grains.

From the Greater Rotl came—

1. Eight of its ounces of $450\frac{1}{4}$ grains = the Marc of Cologne, its double being the German Imperial pound = 7218 grains; our royal Tower-pound of Plantagenet times being 12 ounces = 5400 grains.

The 100 lb. centner of North Germany = 103·1 lb. was almost exactly the same weight as Al-Mamūn's Cantar.

2. WEIGHTS OF EASTERN EUROPE (see Chap. XV)

The Polish pound	16 × 8 dirhems of		48·9 grains	
,, Russian ,,	,,	,,	49·37	,,
,, Austrian ,,	,,	,,	50·6	,,

From 8 dirhems of 50 to 47 grains came the ounces of the pounds of Southern France.

From 10 dirhems of 48 grains, more or less, came the ounces of the Troy pounds.

The weight of the dirhem is now: Turkey 49·6 grains, Greece 49·4 grains, Morocco 49 grains, Egypt 47·6 grains, Tripoli 47·07 grains. In Tripoli there is a small weight = 12·55 grains called a dirhem, which seems to be $\frac{1}{4}$ of an original weight dirhem = 50·1 grains.

The fall of the dirhem weight, and consequently of the weights which are multiples of it, accounts for the

Egyptian Cantar having fallen from its original weight to somewhat over 98 lb.

The quarter-Cantar gave its Arabic name to other quarter-hundredweights, the Arroba of Spain, the Rubbio of Italy, the Rub of Southern France (from Ar. *rouba*, four ; cf. Rubaiyát, quatrain).

Measures of Capacity derived from Arabic Linear Measures

Al-Mamūn's cubit cubed became the medieval standard of grain measure on the Mediterranean coasts—

21·28 in. cubed = 9639 c.i. = 347·314 lb. water,

which is equal to 34·73 gallons or 4·34 bushels.

This measure subsists in Egypt as the Rebekeh = 4·32 bushels. It passed to Marseilles as the Cargo, and to Paris as the Setier.

These developments of the Arabic cubit and foot will be more fully explained in the chapters on foreign systems. They are sketched in order to show how the Eastern caliphate took up the system begun by the great monarchies of many centuries before, and elaborated by Greece and Rome. Thus, from Moslem Egypt as from Pharaonic Egypt have come virtually all the weights and measures of the Western world.

CHAPTER IV

THE INVOLUTION OF LINEAR MEASURES FROM WEIGHTS

The Sources of the English and of the Rhineland Foot

Commerce is the great conservator of standards. These may become altered by the ill-advised action of rulers, by municipal or parochial carelessness, even by the desire of profit on short measure, or occasionally, as seen to a slight extent in our old Bushel, by the faulty dimensions of a standard; but wholesale trade, supported, in weights at least, by the goldsmith and the apothecary, preserved the integrity of many standards during the Middle Ages and up to modern times. Commerce conveyed to the West the standards that had developed in the great Oriental Kingdoms, sometimes with the modifications due to Roman influence. Masons and architects also preserved the standards of length and, allowing for variations inevitable under the feudal system, the principal linear measures can generally be traced to their sources as surely as weights. But there are two, yea three, striking exceptions among the linear standards of the

West: the English foot, and the Rhineland foot, and also the Pán of Marseilles. These are quite unconnected with any ancient measures, and there is no record of their origin. The only clue to it is found in the simple relation of each to the corresponding weights and measures of capacity, the origin of which can be satisfactorily traced. This leads to the hypothesis that these linear measures were 'involved,' that is produced by a method of involution the inverse of that which had evolved the measures of weight and capacity.

1. The English Foot

There seem three hypotheses for the origin of the English foot.

1. That it was the Olympic foot = 12·16 inches, its standard diminished by the accidents of time.

But we know that the Romans established their measures in Britain, and our mile of 8 stadia and of 5000 feet (first Roman, then English) up to Tudor times, shows that it was originally 1000 Roman paces of 5 feet; and our early wine-bushel, of which the wine-gallon was $\frac{1}{8}$, is referable to the cube of the English foot, not to that of the Olympic foot.

There is no trace of the Olympic foot in Northern Europe except the possibility (mentioned under Foreign Linear Measures) of the Amsterdam local foot, = 11·146 inches, being 11 inches of the Olympic foot.

2. It happens that the mean of the Roman foot = 11·67 inches, and of the Rhineland foot = 12·356 inches, gives 12·013 inches. But there is no instance

of a new standard being formed from the mean of two older ones; moreover this hypothesis begs the question of the Rhineland foot.

3. The hypothesis which I consider the most likely is that the foot is the measure of the side of a cubical vessel containing 1000 Roman ounces of water. It seems likely that in early times, possibly under King Alfred by the advice of Italian moneyers or Jewish merchants, this measurement was effected in order to establish a foot and a cubic foot measure of capacity corresponding to a new talent of 1000 Roman ounces. There is no record of this, any more than there is a record of the standard taken for the Tower pound of the Norman and Plantagenet kings. All we know is that, during the times of these kings, the relation of Averdepois or Roman weight to our measures of capacity was utterly ignored until at last, in 1685, 'some Gentlemen at Oxford determined the weight of a cubic foot of spring water, or 1728 solid inches, to be 1000 ounces averdepois.' That the correct weight is not 1000 but about 998 ounces at 62° does not militate against the connexion of the weight and measure any more than the fact that a cubic decimetre of water, supposed to weigh 1000 grammes, only weighs about 998½ grammes would disprove a connexion between the cubic decimetre and the gramme.

The difficulty of making a 'quadrantal,'[1] a vessel of exactly cubical form inside, is so great that the wardens of the Metric System abandoned the cubic

[1] Quadrantal, the Roman standard of capacity, a cubic vessel measuring one foot on each of its inside panels.

decimetre of water as giving the standard, either of the litre for capacity, or of the kilogramme for weight. Even approximate accuracy was unattainable, and they were obliged to make the kilogramme an arbitrary standard of mass and the litre a vessel containing a kilogramme of water.

When it is seen that a difference of 1 in 2500 in the length of the foot taken as the inside measure of a quadrantal makes a difference of 3 cubic inches out of 1728 in its capacity, the material difficulties of constructing a vessel exactly cubical will be understood. However, a quadrantal being constructed, perhaps after many trials of sides as exactly equal as possible, and holding 1000 ounces of Roman ounces (=437 grains) of water, the mean measure of its panels was taken as a foot, and the quadrantal as a cubic foot—the wine-bushel.

Let us take 1000 Roman ounces and divide the total number of grains weight by the statute number of grains in a cubic inch of water as determined by Captain Kater in 1824.

The dividend will be the number of cubic inches, and its cube root will be the foot—

$$\frac{437{,}000}{252{,}458} = 1729{\cdot}8 \text{ cubic inches,}$$

of which the cube root is 12·0042 inches, a length differing by only $\frac{1}{2400}$ from the actual Imperial foot.

I took the idea of this hypothesis from that by which Don V. V. Queipo inferred the Belādi cubit to be the double measure of the side of a cubical vessel containing a Ptolemaïc talent of water. Certainly it

solves the question of the origin of our foot, and it happens that, applied to the equally obscure origin of the Rhineland foot, the results are equally satisfactory.

2. The Rhineland Foot

Let the same process of involution be applied to the side of a cubical vessel containing 1000 Troy ounces of water.

The standard of Troy weight varied very much, from the Danish value of a little over 481 grains in the ounce, to the French Troy value of 472·13 grains.

The Scots Troy weight, = 476·09 grains to the ounce, is nearly the same as the Amsterdam weight, = 476·68 grains.

These Troy weights may be taken at three main standards, high, medium, and low, represented by:

English	Troy,	its	ounce	= 480	grains
Amsterdam	,,	,,	,,	= 476·68	,,
French	,,	,,	,,	= 472·13	,,

Let us apply to 1000 ounces of water, at the medium Amsterdam standard, = 10 Egyptian dirhems of 47·6 grains, the same measurement of a quadrantal made to contain them as exactly as possible.

$$\frac{476{\cdot}687}{252{\cdot}458} = 1886{\cdot}9 \text{ cubic inches}$$

and the cube root of the dividend gives 12·357 inches, exactly, to 1 in 20,000, the Rhineland foot as established in Prussia = 12·3564 inches. The Prussian standard of the Cologne pound (its ounce = 451·1 grains) was $\frac{1}{66}$ of a Rhineland cubic foot of water at 65·75 F., and

was fixed at 7217·9 grains. This was exactly $\frac{1}{66}$ of 1000 Troy ounces of water at the standard of 476·38 grains. So 66 Prussian pounds were equal to 1000 Troy ounces, or to 62·5 Troy pounds at that standard.

The Rhineland cubic foot had, like the English cubic foot, long been the bushel standard of North Germany. The Himt, now, or until quite recently, the unit of corn-measure in Hanover and Brunswick, contained 6·852 gallons, or 68·52 lb. of water. It is probable that the Himt, which passed to Scotland in the fifteenth century as the firlot of that time, had risen slightly, and that it was originally = 68·05 lb., the true Rhineland cubic foot of water.

3. The Pán of Marseilles

Marseilles, a city of Greek origin, always in extensive commercial relations with the Mediterranean countries using the Arabic system of weights and measures, had an almost perfect system of its own, entirely sexdecimal, and dating from about the tenth century. This system is still extant, so far as the French law can be evaded (see Chap. XXI: Old Weights and Measures of France). Wine and corn measures were in the usual Southern water-wheat ratio of 1 to 1·22, and the principal of these was the Escandau for wine and oil, and the Panau for corn. Now Escandau means 'standard'; and this measure was $\frac{1}{4}$ of the Mieirolo, the half wine-load or 'wey' which corresponded in water-wheat ratio to the half-load or wey of wheat. The load of wheat, the *cargo*, was the cubic

cubit of Al-Mamūn, brought from Egypt by the corn-trade. The unit of length was the Pan (pronounced páng), a word apparently similar to the palmo of Italy and Spain, but really different. Palmo becomes *paume* in Provençal, while Pan is from L. *pannus*, a side, pane or panel;[1] and the Marseilles Pan = 9·9 inches is exactly the measure of the side or pan of an Escandau of cubical form. The filiation of the Escandau is evident, while the Pan is not derived from any antecedent measure. That the Pan was the measure of the pan or panel of a cubical Escandau is supported by the name of the corn-standard, the Panau, corresponding to the fluid standard of the Escandau, and of the land-measure, L. *Panalata*, the peck-land, originally the extent usually sown with a Panau of wheat.

Escandau = 16·096 litres = 3·54 gallons.

$\sqrt[3]{16096}$ = 25·24 centimetres, the Pan = 9·9 inches.

The evidence of the Pan seems to me to remove any doubt as to the medieval evolution of linear measures from imported standards of weight or capacity. The meaning of Pan as 'side, panel' is conclusive, especially when supported by the Panau measure and by other Provençal derivatives:

Panard, a limping man, leaning to one side as he walks.

Lou Panard, the star Antares which, rising late and setting early, not appearing much above the horizon, is visible only on one side of it.

[1] The French word *pan* has the same meaning, while Fr. *empan*, a span, is a corruption of *espan*.

4. The Filiation of the English Foot, of the Rhineland Foot, and of the Marseilles Pan

In the description of the ancient cubits and talents and of the Roman system derived from them, the filiation of the English system of weights and measures, and of the Scots and other cognate systems, is clearly seen. There was no taking of a King's heel-to-toe as a foot, no pound imported from some unknown country at an unknown period, no wheat-quarter preserved in the dimensions of an Egyptian sarcophagus, not even a pint from the Roman sextarius ; legend disappears, the course of evolution, and, at one point, of involution, is clear, and as thoroughly scientific as in any system invented by an Academy of Sciences. Here are the links of filiation of the English foot :

1. The Egyptian meridian cubit.
2. The royal cubit, increased from the meridian cubit.
3. The royal foot, two-thirds of the royal cubit.
4. The cubic royal foot.
5. The Alexandrian talent, the weight of a royal cubic foot of water.
6. The Roman ounce, $\frac{1}{1500}$ of the Alexandrian talent.
7. The English talent, 1000 Roman ounces.
8. The volume of 1000 Roman ounces of water, the original wine-bushel.
9. The 1000-ounce Quadrantal becomes the cubic foot, its side giving the English foot.

For the Rhineland and Scots system we have:

1. The Egyptian meridian cubit.

2. The Arabic or Black cubit, 7 palms of the meridian cubit's 6 palms.

3. The Arabic foot, two-thirds of the Arabic cubit.

4. The Arabic talent or Cantar, the weight of an Arabic cubic foot of water.

5. The Troy ounce, $\frac{1}{1500}$ of the Cantar, and coinciding with 10 lesser dirhems of about 48 grains.

6. The Rhineland talent of 1000 Troy ounces Amsterdam standard.

7. The Quadrantal containing 1000 Troy ounces of water becomes the cubic Rhineland foot, its side giving the measure of the Rhineland foot.

For the Provençal system we have:

1. The Egyptian meridian cubit.

2. The Arabic cubit, 7 palms of the meridian cubit's 6 palms.

3. The Arabic cubit cubed, in the corn-measure of medieval Egypt, the Cargo of Marseilles, the Setier of Paris.

4. The half-cargo reduced to wine-measure in wheat-water ratio becomes the Mieirolo; of which one-fourth is the Escandau or Standard measure.

5. The Quadrantal containing an Escandau gives, as the measure of its side or panel, the Pán of Marseilles.

The evolution of the English foot, of the Rhineland or Scots foot, of the Pán of Marseilles, being now made clear, we can proceed to English and other linear measures. The origin of the Ounce, the foot, the

cubic foot or wine-bushel is explained. That of Troy weight has been seen, and its predecessor, Tower weight, came from another ounce of the Arabic cantar. The origin of every measure and weight used in the civilised world will be found in the stories of the ancient cubits and talents.

CHAPTER V

ENGLISH LINEAR MEASURES

1. The Yard, the Foot, the Inch

The term Yard, the Old English 'gerde' or 'yerde,' a wand or rod, became specially applied to a wand of 3 feet, or 4 spans; from this double mode of division and from its convenient length the cloth-yard of 3 feet became generally used. It has the convenience of being a half-fathom, and of being divisible not only into feet and inches, but also sexdecimally into units which are familiar as limb-lengths of the cubit and span system.

The half-yard corresponds to the Cubit.

The quarter-yard is a Span.[1]

The eighth is a Finger; women constantly measure linen approximately by the length of the bent middle finger.

The sixteenth is a Nail; this is the length of the half-finger, the last two joints of the middle finger.[2]

While the yard is lawfully divided into halves, quarters, eighths, and nails, it may also, as a measure

[1] The usual dimensions of bricks are a span by a half-span, by a nail.

[2] The story of the Nail will be found in Chap. XX.

of 3 feet, be divided into 36 inches. Yard-measures are usually divided in both ways, on one side into 16 nails, on the other into inches.

It is customary to say either a yard and a quarter, or 45 inches, or 3 feet 9 inches. Or to say either 58 inches or 4 feet 10 inches; but it is not customary to say a yard and 22 inches. We cease to use the yard as unit when we cannot express its fractions sexdecimally.

The Foot is lawfully divided into 12 inches; but there is nothing to prevent it being divided decimally, or otherwise, as convenient.

The Inch is divided according to convenience, either

Sexdecimally, into halves, quarters, &c., down to sixty-fourths. This is the usual division.

Duodecimally, into 12 lines.

Decimally, into tenths and hundredths.

Steel foot-rules usually show all three of these scales.

Some trades may have special scales. Thus type-founders divide the Inch into 6 'picas' each = 2 lines, and the 'pica' into 12 points each = $\frac{1}{6}$ line or $\frac{1}{72}$ inch. Nonpareil type is 6 points; Brevier is 8 points.

2. Standards of the Linear Measures

Tables of measures, from the earliest, about 1500, down to quite recent times, usually began by stating that 'Three barley-corns make an inch' or that 'Geographical measures begin at a barley-corn and increase upward to a league,' &c.

King David I of Scotland (*c.* 1150) is credited with the pronouncement that the Scots inch was to be the mean measure of 'the thowmys of iij men, that is to say an mekill man and a man of messurabil statur and of a lytell man. The thoums are to be messurit at the rut of the nayll.' But no more in Scotland than in England, or elsewhere, has the inch ever been anything but a division of the foot.

A standard of the English foot was fixed in Old St. Paul's Church, London, and was known as Paul's foot, all measures being referred to the standard 'qui insculpitur super basim columpnæ in ecclesia Sancti Pauli.' In 1273 a deed gave the measurement of land 'according to the iron ell [yard] of the King's palace.'

The present standard yard is a bronze bar kept in London, the length of which agrees exactly with the yard, still extant, of Tudor times. A set of standard measures of length is fixed along the base of the northern wall of Trafalgar Square,[1] and another set is in the flooring of the Guildhall. Sets are also fixed to public buildings in several chief towns of the United Kingdom.

As metal rods vary in length according to temperature, comparisons with a standard measure should be made at the normal temperature of 62°. But there is

[1] The Standards Commission in 1870 advised that the public standards of length should be placed so as to be readily accessible to the public without their use 'being disturbed by passers or idle gazers.' Anyone who has tried to get access to those in Trafalgar Square may regret that there seems to be no provision made against their site being made the usual lounge of often very objectionable persons.

an alloy of steel and nickel (42 per cent.), named Invar, which is not perceptibly affected by temperature.

A pendulum beating seconds at sea-level and at normal temperature measures 39·1393 inches at Greenwich (Act of Parliament, 1824). This length varies in different places from the variations of gravity due to the ellipticity of the earth and local causes of deviation.

3. The Hand

The popular 'hand' was the 'palm' of ancient times, four digits or finger-breadths.

Pes habet palmos iv, palmus habet digitos iv (Frontinus).

'Foure graines of barlye make a finger; foure fingers a hande; foure handes a foote' (Eden, 1566).

But the present Hand for horse-measurement is 'the measure called a Handful used in measuring the height of horses, by 27 Hen. 8, Chap. 6, ordained to be 4 inches' (Sam. Leake, 1701). This is part of an old popular duodecimal division of the foot into 3 hands of 4 inches, then of the inch into 3 barleycorns (lengthwise) each of 4 poppy-seeds, and of these again into 12 hairbreadths.

In Austria this horse-measure is the Faust or fist.

Another very widely spread limb-measure is that of the fist with the thumb projecting, roughly = 6 inches. It is the Shaftment of some parts of England, *scæft-mund* (shaft-hand) in Old English, *bawd* in Wales; the *somesso* of Italy, the *kubdeh* of Egypt, the *taim* of Burma.

In the Laws of Æthelstan (1000) a measurement is given as 9 feet, 9 shaftments, and 9 barleycorns, i.e. 9 feet + 9 half-feet + 3 inches.

4. The Ell

The yard, being 4 spans, was formerly one of the Ells, measures of 3, 4, 5 or more spans, related to the cubit of 2 spans. The Scots yard, of 37 inches, was always known as an Ell, and it was only gradually that our yard took the place, for cloth measure, of the Ell of 5 spans = 45 inches, which was long maintained by statute. The yard and the ell were usually distinguished as *virga* and *ulna* in statutes, but sometimes *ulna* meant a yard.

Both yard and ell were divided into halves, quarters, and nails (sixteenths).

See Chap. XVI (The Ells), and Chap. XX (section on the Nail and the Clove).

5. The Rod, Furlong, Mile, and League

The earliest table of English linear measures is probably that in Arnold's 'Customs of London,' *c.* 1500.

> The lengith of a barly corne iij tymes make an ynche
> and xij ynches make a fote
> and iij fote make a yerde
> and v quatirs of the yarde make an elle
> v fote make a pace
> cxxv pace make a furlong
> and viij furlong make an English myle.

Thus, in 1500, the furlong was $125 \times 5 = 625$ feet, and the mile $= 5000$ feet $= 1666{\cdot}6$ yards.

The mile was originally the Roman mile, 1000 paces or 5000 Roman feet, and $= \frac{5000 \times 11{\cdot}67}{3 \times 12}$ in. $= 1621\frac{1}{3}$ yards. So in course of time our mile had become 5000 English feet.

But the linear unit for land measurement was not, as in the Roman system, a *pertica* or rod of 10 or 12 feet; it became very early, on the Teutonic system, a rod of 16 feet, with varieties, under French influence later on, of 18, of 21 and 24 feet.

In early Plantagenet times, not later than Edward I, the statute rod was fixed at $5\frac{1}{2}$ yards or $16\frac{1}{2}$ feet. Thus, while the rood, that is the field-furlong, was 40 rods or perches of $16\frac{1}{2}$ feet $= 660$ feet, the itinerary furlong, $\frac{1}{8}$ mile, remained 625 feet, 'xxxviij perchis sauf ij fote' (Arnold's 'Chronicle'). This clashing of the new statute rod, and its multiple the rood or field-furlong of 40 rods, with the ancient itinerary furlong now only $= 37{\cdot}87$ rods, was rectified in Tudor times, probably temp. Henry VII, but definitely by a statute of Elizabeth which raised the furlong to coincide with the rood. The mile thus became of its present length, 8 furlongs of 40 rods of $5\frac{1}{2}$ yards $=$ 1760 yards $= 5280$ feet. The mile has then successively been:

1.—Roman mile	of 5000 Roman feet	$= 1621{\cdot}3$	yards.
2.—Old English mile	,, 5000 English ,,	$= 1666{\cdot}6$	,,
3.—New ,, ,,	,, 5280 ,, ,,	$= 1760$	,,

For long measurements chains came into use, and

shortly after 1600 Edward Gunter introduced, for surveying purposes, measurement by a chain of 4 rods, i.e. a 'brede' or 'acre-brede,' the breadth of an acre of 40 × 4 rods, divided into 100 links.

So the multiples of the yard are now:

5½ yards				= 1 rod
22 ,,	or 4 rods, or 100 links			= 1 chain
220 ,,	,, 40 ,, ,,	10 chains		= 1 furlong (rood)
1760 ,,	,, 320 ,, ,,	80 ,,	or 8 furlongs	= 1 mile

The Scots mile and the Irish mile were equally 8 furlongs of 40 rods, but Scots and Irish rods (see Chap. XIV).

Scots mile	320 rods of 6 ells (6·1766 yards)	= 1976 yards
Irish ,,	,, ,, 7 yards	= 2240 ,,

The term Yard has been used for certain large land-measures. These, with the evolution of the Rod, will be given in the next chapter.

The League

It has been seen that the Persian Parasang was three meridian miles, or 3000 Olympic fathoms. France retains this as the *lieue marine* of 20 to the degree, and Southern France long retained a league of 3 miles each of 1000 toises or cannes. But in Roman times the Leuca or Leuga of Gaul was 1½ Roman miles. It passed to medieval England at about the same length, being defined as *duodecim quaranteinis*, 12 furlongs or roods of 40 rods.

CHAPTER VI

LAND-MEASURES

I. Introduction

The first measures of land were seed-measures. They are found in every country; they become fixed in course of time as the idea of geometric measurement arises; they survive in name giving the peasant a concrete idea of the extent of his fields.

Then came the estimation of land by the amount of ploughing, or sometimes of hand-digging, that could be done in a day, and by the extent that could be cultivated with a pair of oxen. Then came a system of geometric measurement, fixing the former seed-units or labour-units by measures of length and breadth, and finally the abstract idea of superficial area. These different systems have succeeded one another everywhere and in all time.

1. Seed-units.—The land that could be sown with a certain measure of seed-corn, wheat being the usual standard: Fr. *seterée, estrée, boisselée,* &c.; It. *moggio*; Sp. *fanega*; G. *scheffel*; Nor. *tunn-land.* These names correspond to corn-measures.

2. Day's hand-labour units.—The land that could be tilled with spade or hoe in a day: the 'Daieswork,' about 10 square rods; Fr. *hommée, ouvrée* = 20 square rods of vineyard.

3. Day's ploughing units.—L. *jugerum*; It. *giornata*; Fr. *journal, arpent*; G. *morgen, joch, acker*; Du. *bouw*; Hind. *bigha*; Ar. *feddan*; Ir. *ardagh*. All about an English acre more or less.

4. Oxgang units.—The land that a boor with a yoke of oxen could keep in husbandry; about 7 acres of arable, about 30 acres including wood and pasture:

Yard-land; Du. *hoeve*. A group of oxgangs, generally of four yoke, made a Ploughland; Prov. *un mas de quatre couble*, a four-yoke farm.

5. Geometric units.—First, units of a certain shape based on the customary length of the furrow: Rood, 40 rods by 1 rod broad; Fr. *vergée, seillon*. Then small units of a square rod, the rod being of customary length; with large units, usually groups of roods, vergées, &c. Four roods side by side make the English or the Norman acre. A rood square or square furlong is the 'acreme' or 10-acre field.

Legal units of land were usually abstract, of so many square rods or fathoms, independently of any customary shape.

2. Evolution of Geometric Land-measures

While smaller units, such as the superficial rod, can easily be conceived as square, the larger arable units have, or have had, a peculiar form which still attaches to them. The peasant, whose mind's eye

can perceive the square rod or toise or verge, refers the rood or the acre, the vergée or the arpent, to the familiar length of the furrow and to the breadth of the rod or of the four-rod acre-breadth equal to a cricket-pitch. These lengths and breadths will long be his essentially concrete standards of field-measurement.

While some legal units of surface have recognised the customary furrow-length as an element of this form, others have always been undefined as to form.

In ancient Egypt the land was surveyed by the state, not only for revenue purposes, but because of the Nile overflow effacing the land-marks usual in other countries.

'Hence land-measuring appears to me to have had its beginning, and to have passed over to Greece' (Herodotus). The agrarian unit of Egypt, called by the Greeks *aroura*, a plough-land, was a square, each side being a Khet or cord, of 100 royal cubits = 172 feet or $57\frac{1}{3}$ yards. The square khet is represented by the present Egyptian feddan al risach of 20 lesser qasáb (each 20 × 4 Hashími cubits) = 170·4 feet square = $\frac{2}{3}$ acre.

Ten square khet made the usual land-holding. This unit, = 6·79 acres, corresponds closely to 10 modern feddan, to the véli or oxgang unit of Southern India, and to the 7 acres of arable in the medieval English boor's yard-land. That the ancient Egyptian oxgang was 10 khets in a line, giving if required a furrow of 573 yards easy in muddy alluvial soil, seems certain, for its hieroglyphic is a line of ten small squares.

This is exactly the primitive form of the English acre, 10 × 1 chains.

In ancient Greece the unit of land-measure was the plethron of 10 rods (kalamoi) each of 10 Olympic feet, = 101·33 English feet. Had it a concrete agrarian form? Evidently the square plethron (= 0·235 acre or nearly a rood) was much too short for a plough-unit; but the larger unit was the tetragyon, i.e. a four-rood field, and with the four square plethra end-on-end, this Greek acre afforded a furrow-length of 135 yards. So it is probable that the tetragyon, 135 × $33\frac{3}{4}$ yards, = 0·94 acre, was the usual concrete agrarian unit.

A common size of land-holding was 12 × 12 = 144 plethra, = about 34 acres, a size corresponding to our medieval oxgang.

In ancient Italy land was measured by the Roman decempeda or pertica, the 10-foot perch or rod, = 9·725 feet.

A strip of land 120 × 4 Roman feet made an Actus, probably the breadth of a double furrow, up and down. The square actus, actus quadratus, = 30 acti = 120 × 120 feet, about 50 square rods.

Two square acti made a Jugerum, the day's work for a yoke of oxen, = 0·623 acre.

Four square acti, bina jugera, made the Heredium, = 1·246 acre.

How were the four square acti arranged? Were they in a square 240 × 240 feet? No doubt that would be the official form of the heredium; but it is probable that, as I have assumed for the Greek tetrag-

yon of 4 square plethra, the 4 Roman acti would be, when convenient, practically arranged in a line, thus giving an agrarian unit of 480 × 120 feet and a furrow of about 160 yards, which is nearly one-tenth of the 5000 feet Roman mile.[1]

The official division of the field was based on the jugerum; this being divided, on the duodecimal or uncial system, into 12 unciæ, each of 24 square perticæ, the latter being the scruples, the qiráts, of the Roman land-ounce. Here we see the uncial system overshadowing the decempeda; for if the jugerum could be divided into 12 ounces of 240 × 10 feet and these into 24 scruples of 10 feet square, each of its two acti might also be divided into 100 sections of 12 feet square, or the double jugerum into 100 sections of 24 feet square. It is probable that this would be a more popular division than that based on the decempeda; for it is certain that a rod of 16 spans = 12 feet was used; it was the Græco-Roman *akena* (from *akis*, goad), a gad or rod.

The Heredium passed to Gaul, where it established itself in the north, becoming the French arpent, 100 square perches, each of 6 aunes (= 24 Roman feet) square, so that the arpent is identical with the heredium, and was divided on the plan I have suggested as that of the Roman land-measure. But the arpent rarely coincided with the standard of the Paris government, and both seed-measures and work-measures, of fixed area, were often preferred. Where the *coutumes de Normandie* are still in almost full force and are cherished

[1] For evidence on the form of agrarian units see Notes in section 5 of this chapter.

by the people, the principal unit of land-measure was, and is still, the Acre de Normandie, containing 160 perches of 24 feet square. The standard of the foot varies; sometimes it is the royal foot, sometimes the Roman foot, retained by the device of taking 11 royal inches for a foot. The ancient standard of this acre is thus expressed in law-Latin: Pertica terræ fecit 24 passus seu soleas pedis; 40 perticæ faciunt virgatam; duæ virgatæ faciunt arpentum; 4 virgatæ faciunt acram. 'Passus' is here a foot; but sometimes it meant a pace, half of the Roman pace which is here represented by the brasse of 5 royal feet = 1·624 metre. So in Normandy land-measure the *pas* = 32 inches and the Caux peasant reckons his vergée as 100 × 20 paces = 88·8 × 17·76 yards. These concrete forms of land-unit are dying out, yet everywhere traces of it can be found in conversation with old peasants.

From the South of France to England and Scotland there is a concrete shape recognisable in the large unit of land-measure. The Provençal Saumado of 1600 square cano or toises, the Normandy acre of 160 square rods of 4 toises, the English acre of 160 square rods of $5\frac{1}{2}$ yards, the Scots acre of 160 square rods of 6 ells = 18·53 feet, are all connected by a common tradition of concrete form, and are all made up of four minor units: sesteirado, vergées, roods, &c. Looking back to the land-measures of Greece and Rome we find this same group of four lesser units in the tetragyon and heredium. The law may only recognise abstract superficial standards, but the peasant holds to the concrete units of form convenient for cultivation.

3. English Land-measures

Notwithstanding Homer's recommendation of mules as 'better far than kine to drag the jointed plough,' oxen are still used in the greater part of the world. In light soils one yoke of oxen is sufficient, but in heavy fallows, with deep-working ploughs, two, three or more yoke were used; and in feudal times it would appear that the four tenants of a hide or ploughland co-operated with their oxen. A furrow of 40 rods could thus be made easily in one breath, and as this length of a rood coincided approximately with the eighth of a mile, that division of the mile was also called a furrow-long or furlong. When ploughing up fallow-land the oxen, on getting to the end of the 'shot,' turned and took breath. The ploughman measured a rod-breadth from the first furrow by means of his goad, Scottice by the 'fall' of it, and this rod-breadth down which the oxen turned, the *tornatura* of Italy, was a rood.

Sometimes between the roods a narrow unploughed strip, a balk of land, was left, marking the roods or 'selions,' four of which, side by side, made an acre, and forty of which made the square furlong, the ten-acre field.

Ploughing in roods, selions, square furlongs, is still far from extinct. In Brittany land is still reckoned by *seillons* of so many furrows wide, or of so many *gaules* or 12-foot rods. In Southern France fields are estimated in breadths of a *destre*, of the 12-foot rod corresponding roughly to the width cleared by a couple of mowers. In our Isle of Axholme, in North Lincoln-

shire, land is reckoned in selions of a rod wide and usually of a furlong in length; these selions or roods being grouped into furlongs, that is, actually or originally, into greater units of a square furlong = 40 roods or 10 acres.

Simple country-folk, whose only ideas of land-measure were taken from the length of the ox-goad and of the furrow, and from the breadth of the long acre-strip of land, came slowly to understand that the surface of a field of irregular shape might be reckoned in acres and rods. A statute of Edward II gave a table of the different breadths of the acre when it was less than forty rods or perches in length:

'When an acre of land containeth ten perches in length, then it shall be in breadth sixteen perches; when it containeth eleven perches in length, then it shall be in breadth fourteen and a half and three-quarters of a foot'—and so on through the different lengths an acre might be.

So people came gradually to abstract the idea of superficial measure from shape and to apply it to land of any figure, however different from a square or a rectangle. Thus measures, always *concrete* at first and taken from some known object of comparison, became *abstract* in men's minds for purposes of calculation. Then came the land-surveyor introducing arithmetic and geometry into the art of measurement, and using the cord or chain instead of the measuring od; and it was also found that decimal calculation would be an improvement in this art.

For purposes of accurate measurement and calculation, Edward Gunter introduced, nearly three centuries

ago, measurement by a chain of a hundred links and twenty-two yards or four rods in length. Its adoption decimalised the land-measures without disturbing them. Ten chains go to a furlong and ten square chains to an acre.

Norden ('Surveior's Dialogue,' 1610) mentions the 'standard chaine, that is by the chaine of 16½ foote.' It was soon after this that the chain was increased to 66 feet or 4 rods, which length was a current unit, the 'brede' or acre-brede, the breadth of an acre.

Measures of Length and of Surface

In the following table each superficial unit is placed opposite the lineal unit of which it is the square:

Lineal Measures		Superficial Measures	
12 inches	. 1 foot	144 square inches . .	1 sq. foot.
3 feet	. 1 yard	9 square feet . . .	1 sq. yard.
5½ yards	. 1 rod	30¼ square yards . .	1 sq. rod.
		40 square rods . .	1 rood
40 rods	. 1 furlong	(4 roods or 160 square rods	1 acre).
		40 roods (10 acres) . .	1 sq. furlong.
8 furlongs	. 1 mile	64 square furlongs (640 acres)	1 sq. mile.

Surveyor's Measure

1 link (7·8 inches) .	·22	yards.	1 square link .	·048	sq. yds.
10 links .	2·2	,,	100 square links .	4·84	,,
100 links (1 chain) .	22	,,	10,000 sq. links (1 sq. chain) . .	484	,,
10 chains (1 furlong)	220	,,	10 sq. chains (1 acre)	4840	,,

It must be remembered that *the length of the rod determined the length of the mile and the area of the acre.* This is shown in the table on the following page.

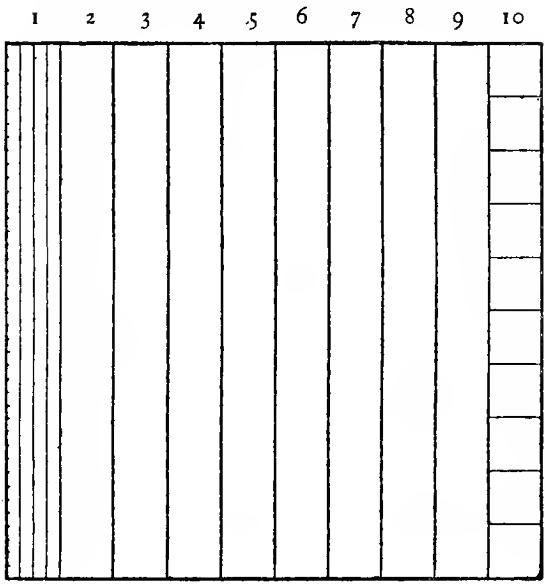
British Miles and Acres Derived from Different Rods in Local Usage

Length	Statute	Scottish	Irish	Cheshire
1 rod	$5\frac{1}{2}$ yards	6·1766 yards	7 yards	8 yards
40 rods = 1 furlong	220 ,,	247 ,,	280 ,,	
8 furlongs = 1 mile	1760 ,,	1976 ,, = 1·123 statute miles.	2240 ,, = 1·278 statute miles.	
Surface				
1 square rod	$30\frac{1}{4}$ square yards.	38·15 square yards.	49 square yards	64 square yards
40 square rods = 1 rood.	1210 ,, ,,	1526 ,, ,,	1960 ,, ,,	2560 ,, ,,
4 roods = 1 acre	4840 ,, ,,	6104 ,, ,, = 1·26 statute acre.	7840 ,, ,, = 1·62 statute acre	10240 ,, ,, = 2·116 statute acre

Note.—The Scottish rod or 'fall' is six Scottish ells or yards. The Scottish and Irish miles have long been practically obsolete. The Lancashire rod and acre, also the Guernsey perch and acre, are the same as the Irish. The Guernsey land-measures are statute locally; the rood or vergée is the customary unit.[1]

[1] It is worth remark that the 160 square rods of the Irish, Lancashire or Guernsey acre being equal to 1·62 statute acres, 100 of these square rods would make almost exactly a statute acre. A rod of 6·957 yards would give a decimal square rod of 48·4 square yards equal 1-10th square chain, or 1-100th acre, or 1-1000th square furlong. A square-shape acre is 69·57 yards square.

A Square Furlong or Ten-Acre Field



Acre No. 1 is divided, according to the ancient custom, into 4 roods, each 40 rods long and 1 rod broad.

Acre No. 10 is divided, according to Gunter's decimal system, into 10 square chains, each 4 rods square.

4. Feudal Land-Measures

In ancient Egypt land was surveyed by a State department, but other Eastern Kingdoms, even of the

present time, are less advanced. There is a simple system of taxing each plough. This was approximately the medieval system, as we see in the Domesday revenue-survey, the great record of the plough-lands and rental of England. Estates are thus described:

2½ hides; land for 1½ ploughs. There is 1 plough with 4 bordars and 4 serfs. Worth 30*s.*

2 hides, land for 2 ploughs, 30 acres meadow. Worth 60*s.*

4 hides, 1½ virgates; land for 10 ploughs. Now worth 14 li., formerly at 17 li.

In some parts the 'knight's fee' was reckoned at 480 acres (4 hides) worth 40 shillings a year. On this valuation—

The pound-land, librata terræ, was 240 acres.

The shilling-land, solidata terræ, was 12 acres.

The penny-land, denariata terræ, was 1 acre.

The farthing-land, ½ obolata terræ, was 1 rood.

Cent livrées de terre a l'esterlin (Froissart) a hundred pound-lands, reckoned of the annual value of 100 pounds sterling. This is sometimes taken as the amount of 'relief,' another feudal estimate, often taken at one year's value.

In Edward I's time a son and heir paid £18 for relief of his land which was worth £18 a year. In Henry II's time £5 appears to be the usual relief paid for a knight's fee on succession to it. By Magna Charta the relief of a whole barony (10 to 40 knight's fees) was fixed at 100 marks; in Henry III's time it was £100.

I may here give a fifteenth-century record of English linear measures.[1]

Nota, for to mesure and mete lande.

It is to mete that iij Barly Cornys in the myddis of the Ere makyth one ynche, And xij enchis makyth a foote
And sixteyne foote and a halfe makyth a perche; And in sum cuntre a perche ys xviij foote.
Fourty perchys in lengyth makyth a Rode of Lande; put iiij therto in brede, and that makyth an Acre.
And xiiij Acrys makyth a yerde of lande;
And v yerdis makyth an hyde of lande, which ys lxx Acrys.
And viij hydis makyth a knyghtis fee, which is vC.lx Acrys of lande.

5. Terms used in Land-measures

Rod.—Pole, Perch, Goad, Lug, L. *pertica,* Fr. *perche, verge,* G. *ruthe,* Du. *roede.*

The equivalent words, L. *virga,* Fr. *verge,* A.S. *geard,* Eng. 'yard,' originally any long straight twig or rod, came to mean: (1) a yard or ell-measure, (2) a rod measure of land, lineal or superficial. The French verge is still thus used in Normandy and the Channel Islands. Our 'yard' acquired this extended sense, and others still more extended. In Cornwall 2 staves (of 9 feet) make a yard of land. In Somerset the lineal rod is the 'land-yard,' and the yard of land is a square

[1] I insert this note (sent to the *Academy* in August 1896 by the late Mr. F. J. Furnivall, who found it in a Bodleian MS.) because it happened to direct my attention to our measures, and was thus the seed whence this book has sprung. The yardland and hide are here of less than half the usual extent.

rod. Thus the rood is 'forty yard o' ground' and the acre is 'eight score yard o' ground.'

ROOD.—A differentiated form of 'rod' applied in a lineal sense to 40 rods, and also to the area of a quarter-acre 40 × 1 rods.

In Normandy and the Channel Islands our rod and rood are verge and vergée, and as the first sense of verge was 'yard' so vergée became in English a 'yard of lande.' So here we have a third sense of the triple-form word virga-verge-yard.

'A rodde of land which some call a roode, some a yarde lande, and some a farthendale' (Recorde, 1542).

The latter term, meaning a 'fourth part,' as in the farthing to the penny, may also have referred to the rood as being a farthing-land in rental. It appears as L. *furendellus, farundel, ferling.*

The rood was also divided into 4 day's-work, each of 10 square rods.

ACRE.—As the rood was sometimes lineal, though usually superficial, so also the 'acre' was sometimes a rough lineal measure, generally an acre-breadth, or 4 rods (a cricket-pitch). But it might also be an acre-length = a rood length. The verse in 1 Samuel xiv.: 'And that first slaughter which Jonathan and his armour bearer made was about twenty men within as it were an half-acre of land which a yoke of oxen might plow,' is in Coverdale's version (1535) 'within the length of halve an aker of londe,' that is, in a length of 20 rods. In French 'arpent' was likewise used for a French acre-length, reckoned, not of the official square arpent, but of the furrow-

long arpent, nearly a furlong. Thus in the Chanson de Roland

> *Einz qu 'hum alast un sul arpent de camp*
> (Before one (he) went a single acre of ground)

evidently means about a furlong, just as in Iliad x., ‘ when he was as far off as the length of the furrow made by mules ’ has the same meaning.

Similarly the *sesteirado* of Provence was used as an itinerary measure, probably of 100 cano = about 220 yards, the same as the centenié.

The *sesteirado*, the rood of Southern France, corresponding to the *boisselée*, the bushel-land of Mid-France, was, like the latter, originally a seed-unit, the extent sown with a *sestié* of seed-corn. Its extent is 0·4 acre, = our rood. Now if this were square, each side would measure 40 yards, a length too small for itinerary measure. Neither Northern nor Southern France had any official itinerary measure under the league, so field-units were necessarily used; in the north the arpent-length, in the south the sesteirado-length; both corresponding to our rood-length, furrow-length or furlong. There seems little doubt that the *centenié*, the popular itinerary measure of the south, 100 cano or fathoms, was the same as the sesteirado-length. And the sesteirado being 400 square cano, it seems that its dimensions were 100 × 4 cano. It was moreover the rood, or quarter of the greater land-unit, the *saumado*, the ‘ seam ’ of land, which would thus be 100 × 16 cano just as our rood was 40 × 1 rods, and our acre 40 × 4 rods. Ten sesteirado-lengths,

10 centenié, made the *milo*, a mile of 1000 local fathoms, one-third of the league of Southern France.

YARDLAND.—L. *quatrona terræ, virgata*. Fr. *bouvée*. Bovate, Oxgang. About 30 acres more or less, including pasture and perhaps some woodland. Before the Norman conquest the gebur-geriht (boor's right) was 6 sheep and 7 acres arable on his yard-land. This corresponds roughly to the German *hufe* = about 20 acres, and to the Netherlands *hoeve*, the unit of small holding. Almost everywhere and always, 6 or 7 acres of arable have been all that the boor's yoke of oxen can till. There was other work for the oxen besides ploughing, and at least five ploughings were usually necessary for proper tillage; then there was cartage and feudal duties in consideration of the small rent.

In the Roll of Battel Abbey (tenth and eleventh centuries) the perch is 16 feet; the acre is 40 perches long and 4 broad and pays a penny a year; 3 shillings for the virgate or wist, the price of which was about 20 shillings. In this case 8 virgates made a hide, but this 'eighth' is exceptional, for the term 'virgate' brought a fourth sense to the virga = yard series of words, giving rise to the term yard-land as a quarter of the plough-land or hide. As the vergée in France (sometimes ambiguously called verge, as it has been seen that Recorde spoke of 'a rodde of lande which some call a roode') and the rood in England were a quarter-acre, and as this quarter-acre was sometimes called a 'yard of land,' so virga-verge-yard acquired the general sense of 'quarter'—either of an

acre or of a ploughland or carucate. Thus in 'Quant une homme est feffe dune verge de terre et dun autre de un carue du terre' (Statute of Wards, 1300), the term 'verge de terre' means not a rod, a verge, but a yardland or virgate.

'Farthing' or 'ferling' as a quarter was used in the same double sense: a quarter-acre or a quarter-hide, indeed, as will presently be seen, a quarter-virgate.

ACREME.—This old law-term for 10 acres of land points to a tradition that our original unit of land-measurement was a rood or furlong square, that is 40 × 40 rods: it was called a Ferlingata or Ferdelh.

A document temp. Edw. II describes the virgate (of which 4 made a hide; 5 hides being a knight's fee) as of 4 (square) furlongs, each of 10 acres.

> X acræ terræ faciunt unam fardellam.
> Decem acræ faciunt ferlingatam; quatuor ferlingatæ faciunt virgatam, et quatuor virgatæ faciunt hidam; quinque hidæ faciunt feodum militis.

So it appears conclusive (1) that the hide was 16 square furlongs, a quarter of a square mile = the quarter section of America; (2) that the acre was originally a slice of land off the square furlong, a rood, or furlong in length, a tenth of this in breadth.

FURLONG AND FERLING.—The square furlong is the same as the Acreme = 10 acres. The square furlong or furrow-long tends to become confused with ferling, G. *vierling*, with fardel, G. *viertel*, with farthendale, Du. *vierendeel*, all meaning a fourth. This confusion arises from the square furlong, similar in

sound to ferling, being approximately the fourth, or farthing, of the virgate or yardland, itself Ferlingus terræ, a fourth of the hide or ploughland. So a ferling may be a fourth of an acre, or of a virgate, or of a hide. Similarly it may be, as farthendale or farendel, a quarter-bushel.

Another cause of confusion in feudal land-measures is the money-estimation of land. Bishop Fleetwood ('Chronicon,' 1707) thought the acre was a marc-land of 160 pence and the rod a penny-land, denariatus terræ, so that the quarter-rod was a farthing-land. He was deceived by the coincidence of the 160 rods of the acre with the 160 pence, 13*s.* 4*d.*, 8 ounces of silver, of the monetary marc, and he mistook the Farthingdale or Farendel, a quarter-acre or rood, for a quarter-rod. The acre was distinctly a penny-land, and the hide of 160 acres was a marc-land, paying 160 pence.

HIDE.—Ploughland, carucate, L. *carucata,* Fr. *caruée.* Normally 16 square furlongs = 160 acres, but sometimes 120 acres or less, varying according to the arable on it; and usually divided into 4 oxgangs, bovates or yardlands. In some parts the hide seems to have comprised several ploughlands and to have coincided with the knight's fee (see Customs of Lancaster).

HUNDRED.—This division of a shire is supposed to have been originally one hundred hides; more probably it was a hundred knight's fees.

6. The Yard and the Verge

These cognate terms have many developments of meaning, running almost parallel both in English and

French. 'Yard,' the equivalent of A.S. gyrd, geard, and perhaps gæd (gad), is cognate to 'Rod' and to Fr. Verge. It may mean:

1. A rod from a tree; L. *virga*, Fr. *verge*.

2. A short measure of 4 to 6 spans; Fr. *verge*.

3. A pole of indefinite length, in various senses, naval, &c. Fr. *verge, vergue*.

4. A long measure of 9 to 24 feet = rod, pole, perch. In France the *perche* may be from 9½ feet (Burgundy) to 22 feet (French).

5. A measure of surface 9 to 24 feet square. Yard, Fr. *verge*.

6. A larger measure of surface 40 × 1 rod = a quarter-acre. Yard-land, rood, Fr. *vergée*.

7. A quarter of a still larger unit. Virgata, yard-land.

8. A holding of a rood when enclosed became a yard or garth, then a cultivated enclosure of any size: tree-yard (Du. *boom-gaard*), apple-garth, win-gaard (vineyard).[1]

Here the Fr. *verge* parts company with 'yard'; its place is taken by *cour* (L. *curtiferum*) and G. *hof*.

9. Any enclosed land attached to a house: Palace-yard, Fr. *cour*. Farm-yard, Fr. *basse-cour*. Court-yard, G. *hof*. Court = farmyard in Somerset.

Fr. *verge* reappears in the English form of 'verge' in the sense of a circle or ring, AS. gyrd, now 'girth.' The gyrd was a geard or yard bent into a hoop. Fr.

[1] Orthodoxly A.S. *gaard* is considered to be unconnected with *geard*, a yard or rod.

verge = ring was a verge or rod bent into a hoop or ring. Cf. Fr. *bague*, ring made by bending a rod or baguette into a hoop. The English sense of ' verge ' = circle is seen in :

> O would to God that the inclusive verge
> Of golden metal that must round my brow.
>
> *Rich. III*, iv. 1.

> To the furthest verge
> That ever was survey'd by English eye.
>
> *Rich. III*, i. 1.

The ' verge ' of the King's palace or court, sometimes stated as twelve leagues (of $1\frac{1}{2}$ miles), a circuit equal to about 3 miles in radius.

7. How the Rod came to be $5\frac{1}{2}$ Yards

The Roman pertica was 10 feet ; though it seems probable that there was also a customary rod of 12 feet.

The French perche was 6 ells of 4 Roman feet, double the presumed customary perch of Rome.

The Scots rod was 6 ells of 3 Rhineland feet.

The German and Norse ruthen are nearly always either of 12 or of 16 feet.

How came it that the English rod was fixed, about the time of Edward I, at $5\frac{1}{2}$ yards = $16\frac{1}{2}$ feet ?

There is reason to believe that it was originally 5 yards, at first in Roman feet, then in Rhineland feet. A length of 5 yards and 1 or 2 inches $(= \frac{1}{8 \times 40}$

of the Roman mile) survives in the Dorsetshire 'goad' or 'lug.'[1]

The Cornish rod or yard is 2 staves of 3 yards = 6 yards. There was, as late as 1540, a rod of 6 yards, 'every pole containing eighten footes of the kinges standard.'

The rod of Guernsey, of Lancashire and of Ireland is 7 yards; it is the French perche of 20 pieds = 21·36 feet taken roughly at 21 English feet; this, and the Cheshire rod of 8 yards = 4 fathoms, are probably of Norman origin.

The English rod of pre-Norman and early Norman times was probably the Teutonic rod of 16 feet, as seen in the Roll of Battel Abbey. How did it become 16½ feet?

I cannot absolutely solve the question; I can only offer the possible hypotheses:

1. That 5½ yards was a compromise between a Southern rod of 5 yards and a Northern of 6 yards. But the former length only survived in the Dorsetshire lug, probably from Roman times, and 16 feet is the probable length of the Southern rod. And such a compromise is most improbable. I know of no measure established as a mean of two different measures.

2. That the length of the 5½-yard rod was taken

[1] Whence the term 'lug' = rod? I venture a derivation:

1. Lug, the ear.
2. Luggie (Sc.), a milking vessel with handles or lugs.
3. Lug, lugge, of land, that can be metely sown with a luggie of seed-corn.
4. Lug, the rod-length of the lug of land.
5. Lug, a rod, as for 'waling' fruit trees.

from that of the medieval lance. Certainly in France there is some evidence of the spear-length being used as a rough land-measure, 'un hanst' or 'une hanstée' de terre. 'Hanste,' in modern French *hampe*, a shaft, is from L. *hasta*. Doubtless very long lances have been used by infantry. The Macedonian phalanx had lances of 8 yards, so that five rows of spear points projected from its front. The Scots lance was 6 ells, the Scots rod, 'That in all, Spears be six Elns in length, under the pain of etc.' (James III); but this length, $=18\frac{1}{2}$ feet, was ordered two centuries later than Edward I, at a time when infantry were brought to resist the onslaught of cavalry. Two centuries later still, it was ordered by 13 Chas. II that a pikeman was to be armed with a pike not under 16 feet in length. It is improbable that in Edward I's time foot soldiers were armed with pikes anything like that length, while the knights' spears could not have been longer than 10 feet. Those shown in the Bayeux embroidery are about 7 feet.

It is possible that the length of the ox-goad may have been used as a rough land-measure, but English ox-goads appear to have usually been only about the length of the Cornish goad, not more than 3 yards long.

Inclined myself to this second hypothesis—for was not Hector's spear of 11 cubits = 22 spans, and are not 22 spans = $16\frac{1}{2}$ feet?—I yet acknowledge that it is scarcely tenable.

3. The most probable hypothesis is that the Rod was originally a North German Ruthe of 16 Norse or Rhineland feet brought over by Saxons or Danes, and

that, established as is seen by the Roll of Battel Abbey 'pertica vero xvi pedes,' it was afterwards adjusted to the standard of the King's foot. Thus 16 Rhineland feet = 16 feet 5·7 inches; which would make the statute rod practically 16 feet 6 inches. In North Germany the Ruthe is usually of 16 local feet, originally, it may be presumed, Rhineland feet, displaced by the local foot = 11·23 to 11·5 inches. Sometimes this fall in the length of the foot is compensated by an increase in the number of ruthen to the 'morgen' or acre, sometimes, as in Holland, by making the *roede* 13 Amsterdam short feet (of 11 inches) instead of 12 Rhineland feet.

It seems likely that the North German acker of 160 square ruthen came to Northern France with the Franks and the Normans, that it became the Acre de Normandie of 160 square rods, the length of the rod becoming changed by the influence of the French standard of 6 *aunes* = 24 Roman feet. This length of 24 feet passed, under Norman influence, to Cheshire, becoming the local rod of 8 yards or 24 English feet.

The rod of 6 *aunes*, French ells, passed to Scotland as 6 ells, but 6 Scots ells = 18 Rhineland feet.

8. How the Acre came to be 160 Rods

The North German acker or morgen is 160 ruthen. Why? It may be presumed that, on the sexdecimal system dear to the bucolic mind throughout the world, it was 16 times an original unit of 10 square ruthen, of 16 feet square, analogous to the Greek plethron of 10 square kalamoi and to the Provençal *cosso* of

10 square fathom-rods. There is still extant, in North Holland, the *snees*, snick, or score, of land, = 20 square roede.

The Austrian joch is 1600 square 'klafter' of 6 feet = 1·42 acre.

There are 1600 square rods in our square furlong, the original square unit of which the acre is a one-tenth slice.

In Provence, the people, long under Roman influence, are yet much more Greek than Roman, and there is not a trace of any Roman standard among their weights and measures. There the greater land-unit is the saumado of 1600 square cano of 6 feet. It is divided in two ways: (1) on the sexdecimal system,[1] (2) into 160 cosso, each of 10 square cano.

It seems as if the 1600 small units in our square furlong, in the Austrian joch, in the Provençal saumado, come from an extension of the sexdecimal multiple 16 to 160 and 1600.

9. Customs of Lancaster

'Customs of places doe differ; for in the Dutchy of Lancaster a knightes fee containeth foure hides of land, every hide foure ploughlands called in latine carucata terræ, and that is quantum aratrum arare potest in æstivo tempore, and that is (as I take it) which is in the North parts called an Oxegange. And every ploughland or carue is foure yard land which

[1] Concordantly with the sexdecimal system of corn-measures into 4 sesteirado, or 8 eiminado. See Seed-measures in Section 10.

in latine is called quatrona terræ; every yardland thirty acres, halfe a yard land in some places in the West is called a Cosset, half a Cosset is a Mese which containeth about 7½ acres. But commonly a carue or plow-land containeth a hundreth and twenty acres; a hide of land 480 acres and every knightes fee 1920 acres. But after some computations, a knights fee containeth five hydes of land, every hyde foure yard land, and every yard land twenty foure acres.' ('The Surveior's Dialogue,' by J. Norden, 'at my poore house at Hendon, 27 Martis 1610.')

So in Domesday Book it will be found that 'inter Ripe et Mersham,' between the Ribble and the Mersey, the hide was not synonymous with the carucate. The series of feudal measures appears to have been there:

Acre, of Lancashire standard = 1·62 statute acres.

Bovate or Virgate of about 15 acres, paying about 4 pence 'relief' to the king.

Carucate or Ploughland, of 8 bovates, paying about 32 pence.

Hide of 6 carucates, paying about one pound.

These feudal measures were evidently vague and variable. The King's assessment was very much the same as it was in Upper Burma fifty years ago. There no survey was required; the land-tax (very light, as the king's revenue was derived, as in medieval England, from forest and other monopolies and from fines) was one rupee a plough, that is for a plough and a yoke of cattle. The Norman kings' assessment was for the common plough of the whole carucate, 4 oxgangs.

10. Seed-measures of Land

When men, emerging from the pastoral stage, took to agriculture, land was plentiful and would roughly but conveniently be estimated by the quantity of seed-corn required for it. Thus seed-units of land were the earliest, and many survive to this day.

It was ordered in Israel (Lev. xxvij.) that land should be 'estimated according to the seed thereof, an homer of barley-seed shall be valued at fifty shekels of silver.' Taking the homer at 8 bushels, a homer of land = 3 or 4 acres, was worth 50 shekels, or half-crowns, of silver.

The Romans had the modius of land, sown with a modius, about ¼ bushel, of corn.

In Northern France there is still the *bonnier* of land, about 4 acres, sown with a *boune* or *bounie* of seed, about 8 bushels.

Throughout the greater part of France the land is reckoned in *seterées* or *sesteirado*, units now fixed but originally named after the variable *sétier* of seed-corn. Smaller units are the *mine* or *eiminado*, and *boisselée*, all seed-units.

In North Germany the Scheffel, or Schepel (Du.), corn-measure is also a land-measure of about half an acre. The Schepel passed from Holland to New England as the Skipple, a bushel-skip. In North Germany and Norway there is the Tunn or Tonde, a barrel of about 4 bushels, corresponding to the Tonde-land of about 1⅓ acre (roughly equal to the French *estrée*).

To the Salma of Italy, to the Saumado (she-ass load) of Provence, corresponds the old English Seam, the Quarter of corn. The word seam hence got the general meaning of a quarter. So although the Seam of Corn would sow 4 acres, a seam of an acre meant a quarter-acre.

'A Sester or Sextarius was what we call a Quarter or a seam containing 8 bushels (Sauma, quod unius equi fit sauma, i.e. sarcina)' (Bishop Fleetwood, 1707).

There are still traces of seed-measures to be found in some parts of England. But in 'A pek of londe'—'Half a pek and a nayle of londe' (Rolls of Parliament, 1442),[1] it is doubtful whether the peck of land was really a seed-measure or a quarter-acre, as the peck is a quarter-bushel. A nail of land would be $\frac{1}{16}$ acre.

There were seed-measures of land in Scotland. Thus: '15th Cy. Chart Aberd. Als mekill land as a celdr of aits will schawe,' i.e. a Chalder of land, as much as a chalder = 64 firlots = 55 bushels, will sow, about 25 acres. There was also the Lippy of land, that which took a lippy, $\frac{1}{16}$ firlot of seed. It was usually about 100 square yards.

In many parts of Southern Europe there are no other kinds of land-measure than those derived from the corn-measures of seed required.

Thus in Provence, the earliest civilised country in medieval times, the whole series of corn-measures and land-measures have names in common.

[1] Quoted in the *New English Dictionary*, a treasury of quotations, which has often put me on the track of valuable information.

Corn-measures		Land-measures		Sq. cano
Saumado	4·4 bushel.	Saumado	1·58 acre	1600
Sestié	1·1 ,,	Sesteirado	0·4 ,,	400
Eimino	4·4 gallon.	Eiminado	0·2 ,,	200
Quartiero	1·1 ,,	Quarteirado	0·05 ,,	50
Pougnadeiro	$\frac{1}{4}$,,	Pougneirado	0·01 ,,	$12\frac{1}{2}$
Cosso (Sc. Luggie)	$\frac{1}{5}$,,	Cosso (Sc. Lug.)		10

These land-measures would correspond to Coomb-land, Bushel-land, Peck-land, &c. The Cosso of land is $\frac{1}{160}$ of the Saumado, as our square rod is $\frac{1}{160}$ acre.

In Italy and Spain there are similar series of land-measures named after corn-measures.

CHAPTER VII

ENGLISH COMMERCIAL WEIGHTS

I. The Story of Averdepois

The story of our Imperial system has hitherto been utterly obscure. The origin of our foot, our gallon, our pound, indeed of all our measures, was quite unknown. That of the pound, which gives the key to the whole system, had been obscured by statutes which ignored any but the royal pound used at the mints. Yet these statutes, often purposely obscure, can be made to show the hidden sources of our system.

Our pound, settled at its present Imperial standard in the time of Queen Elizabeth, was then found to have risen slightly since the time of Edward III. It was found to have increased by about 8 grains. The ounce, now = 437½ grains, had been 437 grains, the same weight as the ounce of Egypto-Roman pound, the Roman libra.[1] There is every reason to believe that this Roman standard passed to Britain, and that the libra, raised to 16 ounces, became the commercial

[1] The modern *libbra* is 12 ounces = 436·27 grains in Rome, 436·66 in Florence.

pound, afterwards known as Averdepois, and now the Imperial pound.

When the Romans took the Alexandrian talent as the standard of their new libra-system, they divided it into 125 libræ, which were 1500 ounces or double-shekels, each ounce = 437 grains.

When the Arab Caliphs conquered the southern and eastern Mediterranean countries, they found in Egypt the Egypto-Roman pound, $\frac{1}{125}$ of the Alexandrian talent; they adopted it, and divided it for coin-weight purposes into 72 mithkals, just as the Roman Emperors had divided the old As pound into 72 aurei; so 6 mithkals = the libra-ounce of 437 grains, just as 6 aurei = the As-ounce of $420\frac{2}{3}$ grains. It is not improbable that the survival of the Roman commercial pound in Saxon England was strengthened by commercial and scientific relations with the Moors of Spain. King Offa of Mercia struck a gold coin with an Arabic inscription, dated 157 of the Hejira = A.D. 774.

However this may have been, there seems no doubt that the Roman pound, raised to 16 ounces, was the standard of England before as after the Norman conquest, and there is no evidence of it having ever been in abeyance. In early Plantagenet times there was a sexdecimal series of weights:

The Stone of 16 lb.

The Wey of 16 stone = 256 lb.

There was also the Hundredweight, of which 20 made a ton of 2000 lb.; and 20 weys made a Last of approximately 5120 lb. or $2\frac{1}{2}$ tons.

The pound was divided into 16 ounces, each = 437

grains, and the ounce into 16 drams or drops = 27·3 grains.

Both before and after the Conquest there was another pound used in the mints, like the As in Rome. It was of Tower, or Cologne-marc, standard. There were doubtless many local variations of commercial standard, especially in measures of capacity, and it was the necessity of checking these which made King John and his successors declare that 'there should be one standard throughout our kingdom, whether in weights or in measures.'

But the king had a mint-pound of his own, and he had to reconcile the existence of the coinage-pound and of the commercial pound with the customary declaration of unity of weight made in each reign. The king's councillors evaded the difficulty by pretending that the measures of capacity were based on the mint-pound and, in statutes where a commercial pound had to be mentioned, by pretending that this was equal to 25 shillings weight or 15 ounces of the mint-pound. This deception led to others, so that, to make out the meaning of a statute of weights and measures, one must be able to read between the lines, and to be prepared for misleading and contradictory statements. I will take as an instance, Act 51 Henry III (1267):

> An English peny called a Sterling, round and without clipping, shall weigh 32 wheat corns in the midst of the ear; and 20 d. do make an Ounce, and 12 Ounces one Pound, and 8 Pounds do make a gallon of wine and 8 gallons of wine do make a London Bushel which is the eighth part of a Quarter.

This declaration may be thus interpreted :

In the Tower there is a standard pound. An English silver penny should weigh $\frac{1}{240}$ of this pound and $\frac{1}{20}$ of its ounce, and the penny-weight may be divided into 32 aces or little grains. But there is another old-established pound used for all goods but gold and silver, bread and drugs. Our regard for the unity of weight forbids us to describe this pound otherwise than by mentioning that a wine-gallon contains 8 of these pounds weight of wine or of water, that 8 larger gallons each containing 8 pounds, not of wine, but of wheat, make a Bushel ; and that 8 of these bushels make a quarter of a Chaldron containing a ton or 2000 lb. of wheat.

That this is correct is easily proved.

The Bushel is $\frac{1}{8}$ of the Quarter, which was the quarter of a chaldron, the measure of a ton of 20 true hundredweight. The quarter was 500 lb. of average wheat, and the bushel weighed $\frac{500}{8} = 62\frac{1}{2}$ averdepois lb. of wheat or, in wheat-water ratio, 78 lb. of wine or of water, the specific gravity of which differs but little. But 8×8 Tower lb. of wine $= \frac{5400 \text{ grs.} \times 8 \times 8}{7000}$ $= 49{\cdot}4$ averdepois lb. or, to be quite accurate, 49·5 lb. of early Plantagenet averdepois weight, when the ounce was of Roman standard, 437 grains ; how then could the bushel = 78 lb. of wine, be the measure of 49·5 lb. of wine ?

That there were two different gallons, the one for wine, the other for corn, is shown in the Ordinance 31 Edw. III, where it is ordered that ' 8 lb. of wheat

shall make a gallon.' It is true that this is continued by 'the lb. shall contain 20 s.'; but very soon after the ordinance states that, for everything except groceries, each lb. shall be of 25 s., and we know that the 25 s. was merely a subterfuge to show the averdepois pound as 15 ounces Tower, afterwards 15 ounces Troy, neither of which it ever was: we may therefore dismiss this statement, and recognise that the wine-gallon held approximately 8 averdepois lb. of wine, and that the corn gallon, about one-fourth larger, held 8 averdepois lb. of wheat.

Further evidence is to be found in 12 Henry VII (1496).

This statute, after the usual preamble about 'one weight and one measure,' orders:

> That the measure of a Bushel contain 8 gallons of wheat, and that every Gallon contain 8 lb. of wheat of Troy weight, and every Pound contain 12 ounces of Troy weight, and every Ounce contain 20 sterlings and every Sterling be of the weight of 32 Corns of wheat that grew in the midst of the ear of wheat according to the old law of the land.

While the bushel is now described as containing 8 gallons of wheat and each gallon 8 pounds of wheat, the old fiction is kept up that these are royal pounds. Only these pounds are now Troy, of 5760 grains, instead of Tower, of 5400 grains; 64 Troy pounds were equal to $52\frac{2}{3}$ lb. averdepois, a weight still far from the $62\frac{1}{2}$ lb. averdepois of wheat contained in the extant bushel-measure of Henry VII. And though the mints were coining 420, instead of 240, pennies from

the 5760 grain-pound of silver, so that these were little more than half the weight of Henry III's pennies, yet they were still of the weight of 32 wheat-corns.

The substance of this statute was embodied in a State-document adorned with a picture of the King's Steward presiding over the gauging of bushels and weighing of wheat-corns, surmounted by a picture of two entwined wheat-ears with the inscription:

THE CONAGE OF THE MYNTE.

The whete eare. Two graynes maketh the xvi p^{te}. of a penny, ffower graynes maketh the viij p^{te}. of a penny.

After this impudent assertion one is not surprised to read that it was 'the same tyme ordeired that xvi uncs of Troie maketh the Haberty poie a pounde for to buy spice[1] by,' nor by the statement that 'the C is true at this daye, ffyve score for the hundred as appeareth in Magna Carta.'

Comment on these ingenious statements seems hardly necessary.

The only changes in English weights since the time of Henry III, or indeed much earlier times, have been:

1. The raising of the hundredweight to 112 lb.

2. The lowering of the stone from 16 lb. to 14 lb. to make it one-eighth of the new hundredweight.

3. The rise of the averdepois pound from 16 Roman ounces of 437 grains to 16 ounces of 437½ grains; a difference of 8 grains, so as to make it 7000 grains of the Tudor Troy pound.

[1] Probably in the meaning of the Dutch *spijs*, food.

4. The re-legalising of the 100 lb. or cental weight in 1879.

I may observe that the octonary series of measures of capacity, also of the 14 lb. stone and new Cwt., is quite in harmony with the sexdecimal system, however objectionable be those units.

The Recognition of Averdepois Weight

It is not until 1485 (Ripon Ch. Acts, quoted in the 'New English Dictionary') that we find mention of averdepois, though there had been standard weights of it from temp. Edw. III, 'per balance cum ponderibus de haberdepase,' and those standards were extant in the time of Elizabeth.

The document embodying 12 Henry VII (1496) mentions, as has been seen, the Habertypoie pound, with the assertion that it was 16 Troy ounces, an assertion causing confusion for centuries afterwards.

In Arnold's 'Customs of London,' *c.* 1500, there is mentioned 'the Lyggynge Weyght, by which is boughte and solde all maner of marchaundise as tynne, ledde . . . and al maner of specery . . . and such other as is used to be solde by weyght; and of this weyght xvj uncis make a pound, and C and xij li. is an C, and x C make a M of all suche marchaundises . . . except wulle.'

This 'lying weight' was by the balance, the weight lying in one scale, and not hanging or sliding on the beam of a stilyard as in Auncell weight. The stilyard, very portable, as not requiring heavy weights, yet admitted of fraud. Arnold says 'this weight is

forboden in England by statute of parlement, and also holy church hath cursed in England all that beyen or sellen by that auncel weyght.'

In 1532 it was ordered by 24 Henry VIII that meat 'shall be sold by weight called Haver-du-pois,' and in 1543 Recorde ('Ground of Artes') says, 'But commenly there is used an other weyght called haberdyepoyse in which 16 onces make a pounde.'

In 1545 the Custom-House notified that 'thys lyinge and Habardy peyse is all one.'

Having cleared away, as I hope, the obscurity which so long hung over the commercial weight ignored by the statutes, it may be well to mention that 'Averdepois' is the best spelling of this word, and is so accepted by the 'New English Dictionary.' 'Aver' is an old-established English word for 'goods,' and the earlier form 'Haberdepase' shows the original pronunciation. The spelling of the last syllable in 'Averdepois' is a sufficient concession to an incorrect modern custom.

The term originally applied to heavy goods, such as came from beyond sea; if the word was sometimes spelt, as in 25 Edw. III, 'bledz, avoirdepois, chars, pessons' (corn, heavy goods, meat, fish), it does not follow that the *oi* diphthong was pronounced as in 'boy.' The word *pessons*, now written *poissons*, shows the sound-value of the diphthong. The sound now given to it in modern French is a corruption. Up till 1700, even in Paris, *oi* was pronounced *é* or *wé*. 'Averdepez' is the true pronunciation. However, the influence of 'poise' prevents any improvement

on the word being written and pronounced as 'Averdepois.'

Though measures of capacity had always been on an averdepois basis, the admission of averdepois weight to statute recognition only dates from the time of Elizabeth. In her reign light begins to appear in our system of weights and measures. In 1574 she ordered a jury to examine the standard weights (many of Edward III and succeeding kings), to report on them, and to construct standards 'as well of troy weight as of the avoirdupois.'

The standards made by this jury were as unsatisfactory as their report. Little could be expected from persons who could, with Edward III's standard weights before them, report that 'the lb. weight of avoirdepoiz weight dothe consiste of fiftene ounc troie.' This was in accordance with the old fiction that the averdepois pound must be a commercial offshoot of the royal pound, that it was 15 ounces Tower = 6750 grains, and afterwards in Tudor times 15 ounces Troy = 7200 grains, or even 16 ounces Troy = 7680 grains.

Elizabeth and her advisers were not deceived by this obsequious report, so, the standards made being found very erroneous, in 1582 a second and more intelligent jury of goldsmiths and merchants was appointed, and the result of their work was the production of 57 sets of standard Troy and averdepois weights, which were distributed to the Exchequer, to cities and towns. Some of these averdepois weights are still extant and do not now differ by more than one grain in each pound from Imperial standard.

The Proclamation for Weights of December 16, 1587, established averdepois weight, and ordered that 'no person shall use any Troy weight but only for weighing of bread, gold, silver and electuaries and for no other thing.'

It seems probable that, in the two centuries before Elizabeth, the standard of the commercial pound had risen by about 8 grains. This may have occurred when the Troy pound superseded the Tower pound. In the adjustment, which I assume as probable, of the Troy and Averdepois pounds so as to obtain a ratio of 5760 to 7000, the latter standard, raising the ounce from 437 to 437½ grains, and the pound by 8 grains, may have been adopted so as to avoid or diminish the cutting down of the new Troy pound.

Thus was established by Elizabeth the English standard of weight. Excellent standards of capacity and of length were also made; and she established our silver coinage on its present basis.

And yet, well into the nineteenth century, even into the twentieth, went on the puzzledom of our weights and measures, left to arithmetic book and almanack makers blinded by the glamour of the royal pound.

No official utterance came to clear the darkness, for it was not till 1855 that the pound, then established as an Imperial standard, was really defined.

2. The Imperial Pound

It is the weight in vacuo of a certain piece of platinum kept in London. It is divided into 16 ounces, approximately Roman ounces. The ounce may be divided into 16 drams.

The pound is also divided into 7000 grains, the ounce being $437\frac{1}{2}$ grains.

It may be well to anticipate or remove any uncertainty about the grain. The averdepois pound was only divided into ounces and drams (just as the yard is only divided, as a yard, into quarters and nails), but on its adjustment with the troy pound as = 7000 grains of which the latter = 5760, it became divisible into grains. These were long called Troy grains, in consequence of the superstition about the noble Troy weight. This word seems to have paralysed the intelligence of many persons doubtless sensible enough in other matters; thus Rees' 'Cyclopædia' (1819) informed its readers that 'the pound or 7680 grains avoirdupois equals 7000 grains troy, and hence 1 grain troy equals 1·097 avoirdupois.'

The weight of the standard pound in a vacuum (that is, its weight not diminished by the buoyancy of the air) being 7000 grains, a commercial brass pound exactly equal to the platinum standard when weighed against it in air at 62°, would weigh 7000·6 grains in a vacuum.

The Dram

This, $\frac{1}{16}$ of an ounce = $27\frac{1}{3}$ grains, is principally used as a unit for powder in the cartridges of sporting guns. In Scotland it was called a 'drop.'

1673. A quech weighing 18 unce and 10 drop.

1805. An arrow of from 20 to 24 drop weight ('N.E.D.').

The dram was possibly so called from its correspond-

ing to the quentchen, $\frac{1}{8}$ of the German Loth or half-ounce ($\frac{1}{16}$ of a marc) as the drachm was $\frac{1}{8}$ of a medicinal ounce.[1] Or it may merely have been called a dram as being the part of the ounce, in the same way that the drachm was the next lower part of the apothecaries' ounce.

3. Scientific and Medicinal Divisions of the Pound

For scientific purposes the pound is considered as of 7000 grains. It may be divided into tenths, hundredths, thousandths; this last division being called a Septem, as = 7 grains. The tenth of this might be called a Septula = 0·7 grain, and the hundredth a Septicent = 0·07 grain. This small weight would be one 100,000th of the gallon, the same proportion as the centigramme to the litre. In analyses of water the solid constituents are usually stated in centigrammes to the litre, or parts in 100,000; and as grains to the gallon or parts in 70,000 they have to be divided by 0·7 to get that ratio. Septicents to the gallon would be the English equivalent of centigrammes to the litre.

An Apothecaries' Troy ounce lingers in the Board of Trade list of standards, for a permissive use utterly unrequired by medical prescribers or by druggists; the British Pharmacopœia only recognising Imperial weight, the ounce and the grain. For convenience, a

[1] The dram of spirits is a measure probably so called from its being $\frac{1}{8}$ of a pint, i.e. half a quartern.

weight of 60 grains is called a Drachm, and one of 20 grains is called a Scruple. It is most rare for prescriptions to contain an ounce of any solid medicine; and when an ounce of such a medicine is most exceptionally prescribed, it might be an Imperial ounce, just as ounces of fluid medicines prescribed are Imperial ounces.

4. The Long Hundredweight

The multiples of the pound were originally, like its divisions, in a sexdecimal series, with an alternative series to bring in the hundredweight, i.e. the true Cwt.

16 lb.	1 stone		
16 stone	1 wey	=	256 lb.
2 weys	1 quarter	=	500 lb. approximately
8 ,,	1 ton	=	2000 lb. ,,
16 ,,	1 last	=	4000 lb. ,,

The approximative relation of the quarter, strictly speaking of 512 lb., mattered but little, as it applied to corn-measure, in which the measured quarter, 8 bushels, varied from 500 lb. for wheat of $62\frac{1}{2}$ lb. to the bushel, to 512 lb. for heavy wheat of 64 lb. to the bushel. The arrangement was convenient for the corn-trade and could not give rise to fraud; and the main object of all laws on weights and measures should be to prevent fraud, especially in retail trade.

This convenient arrangement was altered in the times of Edward I and Edward III. The former King found the Cwt. of 100 lb. with a quarter of 25 lb. and a

sixteenth = $6\frac{1}{4}$ lb. as its nail or clove. In his Acts there is mention of the 100 weight, the 1000 weight, the 2000 weight. But by the Ordinance of Measures 31 Edw. I, 1302, a distractingly obscure statute, no less than three different weights are ordered for the stone:

A stone for lead of 12 lb.

A London stone of $12\frac{1}{2}$ lb., one-eighth of the true Cwt.

A stone for groceries of 8 lb.; and $13\frac{1}{2}$ stone to make a Cwt. of 108 lb.

And the 'fotmal' of lead is to be 6 stones of 12 lb. but less 2 lb., 'which are 70 lb. making 5 stones.'

Here then we see, besides a 12 lb. stone for lead,

(*a*) The true Cwt. of 100 lb. divided into quarters and nails.

(*b*) A transitional Cwt. of 108 lb. in $13\frac{1}{2}$ old half-stones of 8 lb.

(*c*) A new Cwt. of 112 lb. in 8 stones of 14 lb.

The Cwt. (centena) of 108 lb. seems to have been preparatory to the Cwt. of 112 lb. mentioned in this Ordinance (if it be not a later interpolation) and established later by Edward III. It preserved, for a time, the ancient half-stone of 8 lb., but by the inconvenient process of making $13\frac{1}{2}$ of these as the Cwt.; probably to prepare the merchant for a new Cwt. of 112 lb. first in 14 stones of 8 lb. and then in 8 stones of 14 lb.

This is the Cwt. which has come down from Edward III to the present day, against which trade has had to struggle more or less successfully ever since, and which

torments the schoolboy with sums in tons, cwts., qrs. and lb.

To this day the old Stone of 16 lb. or its half, the Clove of 8 lb., still continues in use. The butcher's and fishmonger's stone is 8 lb., and cheese is sold, in most parts of England, by the 16 lb. stone, as it was five or six centuries ago. In 1434, by 9 Henry VI, it was ordered that the Wey of cheese should contain 32 cloves, yet we learn from Arnold (1500) that the weight of Suffolk Cheese is xij score and xvj lb., the same weight as the wey ($16 \times 16 = 256$ lb.), and Recorde (1543) says that for butter and cheese 'a clove containeth 8 lb. and a wey 32 cloves which is 256 lb.' By 10 Anne (1712) a barrel of soap is to contain 256 lb., i.e. a Wey.

The Plantagenet 14 lb. stone is used for flour and potatoes, &c., but the load, the modern form of the wey, is 18 stone of 14 lb. = 252 lb., evidently an approximately near substitute for the 16×16 lb. = 256 lb. of the Wey, there being until quite recently no lawful weights allowed above 7 lb. but in multiples of that weight. The load, like the wey, has the advantage of being equal to 4 bushels of heavy corn at 63 lb., so that it is half of the Quarter and an eighth of the wheat-chaldron or ton-measure.

What was the reason for the Plantagenet Cwt.? for the inconvenient unit, rightly rejected by our brethren in North America, and in several colonies?

Edward I's intermediate Cwt. of 108 lb. seems to show that it was intended to bring our Cwt. up to that of foreign countries using Troy pounds, 108 lb. being

very close to the French and Flemish quintal (Arabic cantar) of 100 Troy lb. The wool-trade with Flanders, the dominion of the Plantagenets in France, may have been the motives for this increase.

The hypothesis that the Cwt. was made 112 lb. so as to be equal to 100 long Troy lb. of 16 Troy ounces, is excluded by the ratio of averdepois to long troy being 100 to 109·7 and also by the new Cwt. dating at least from the time of Edward III, when the royal lb. was still Tower, not Troy, with a ratio to averdepois of 100 to 128 ; and it was certainly not of 16 ounces.

The only lawful multiples of the Imperial pound were, until quite recently, those of the stone series :

7 lb. . .	a clove.
14 lb. . .	a stone.
28 lb. . .	a quarter-Cwt.
56 lb. . .	a half-Cwt.
112 lb. . .	a Cwt.
2240 lb. . .	a ton.

And the only lawful weights were those of 56, 28, 14, 7, 4, 2, and 1 lb.

I have had some personal experience of the inconvenience of these weights. For years I had to weigh recruits and other soldiers, recording their weights in pounds with this inconvenient set of weights. To get the weight of a man of 152 lb. I had to reckon 2 × 56 lb. + 28 + 7 + 4 + 1 lb. Errors were necessarily frequent when many weighings had to be rapidly done, so I had a set of decimal weights made—20, 10, 5 lb.—and all trouble ceased. But these weights were not lawful, at least for trade purposes.

There was, however, another lawful unit, the Cental, that is, the original English Cwt., brought back to England from North America by the corn-trade. Commerce demanded the recognition of the Cental and got it in 1879.

In 1902, the tobacco-trade in Liverpool, annoyed at the inconvenience of the lawful units of weight, as inconvenient for the wholesale tobacco-warehouse as for my military purposes, moved the Liverpool Chamber of Commerce to get the Board of Trade to allow them to use a half-cental weight; a whole cental, the only lawful unit of the kind, being too heavy for handling. In reply to this request, it was suggested that a nest of weights, 28 + 14 + 7 + 1 lb. = 50 lb. might be used. To this the tobacco-trade objected, and after correspondence, the use of a 50 lb. weight was granted. Then they requested permission to use smaller fractions of the cental, in fact a decimal series of 20, 10, 5 lb. And they obtained it. So, thanks to the perseverance of the Liverpool tobacco-merchants and Chamber of Commerce, the decimal fractions of the Cental are now lawful weights, and no one need use the inconvenient 14 lb. stone series.

5. Wool and Lead Weight

Wool Weight

The revenue of the Plantagenet kings being largely derived from duties on the export of wool, the weight of the sack was fixed by statute. By 31 Edw. I 'the sack of wool ought to weigh 28 stone of 12½ lb.' =

350 lb. By 14 Edw. III 'the sack shall contain 26 stone and each stone 14 lb.' = 364 lb., i.e. 2 weys of 13 stone. This regulation was supported by other statutes, in 1389 and 1496, and appears to have had due effect, for it is the standard at the present time: 26 stone or 13 'tods.'

Why was this particular weight ordered?

Possibly because the sack thus corresponded nearly to the skippund (ship-pound) of the Baltic trade and of Scotland, a weight of 20 lispund each of 16 Norse Troy pounds or of 20 pounds of light standard = 352 to 375 lb. The Baltic skippund at the present day is about 350 lb.

In Scotland the sack of wool was ordered to be 24 stone, which was equivalent to 26 English stone, in proportion to the heavier weight of the Scots pound.

The Plantagenet domination in France caused the stone to pass there, though not always at English weight; and there being no regular weight in France between the pound and the quintal, local stones came into use. 'Les laines vend on par sacs et par pois, par pierres, par claus et par livres,' the French terms for the sack, the wey, the stone, the clove and the pound.[1] Sometimes the stone was called 'gal' (stone, *galet*, shingle) and the clove 'demi-gal' (Livre blanc de l'hotel de ville d'Abbeville). The French stone was of variable weight. One record gives the sack of wool (=4 Montpellier light quintals) as of 25 pierres, which would make them 9 lb. each. Another record gives it as 36 stone of 9 standard pounds (= 10 English pounds).

[1] See section on the Nail and the Clove, Chap. XX.

The stone appears to be extinct now in France ; I find that as late as 1579 wool was sold in Burgundy by the wool-stone (*la pierre de laine*) = 12 French or about 13 English pounds.

While the old English wey or load was 16 × 16 = 256 lb., the wey ordered for wool was half a sack = 182 lb. It would seem that, once the King's dues paid, the shipper was free to make up his sacks or sarplers of wool as most convenient to him. The customary wey or weigh (Sc. waugh or wall) seems to have been 32 cloves or nails of 7 lb. = 2 cwt. A ' poke ' of wool ' weand 4 C. 15 nallis,' i.e. 4 cwt. and 105 lb. A sack might be ' 6 wall and 25 naill,' i.e. 12 cwt. and 175 lb.

The wey or weigh became, in statute French, *poids, pois* ; but the scribes took the wrong *pois* and thinking it meant ' pease ' made it *pisa* in their Latin, just as they took the wrong ' nail ' and made it L. *clavus*, and in French *clau*, through L. *clavis*, meaning a ' key.'

Lead Weight

While the fother is $17\frac{3}{5}$ cwt. for coal, it is $19\frac{1}{2}$ cwt. = 2184 lb. for lead. This peculiar unit, also called the char or load, is the consequence of a statute 31 Edw. I, perhaps the most confused and bewildering of the many confused medieval statutes on weights and measures, and one in which subsequent interpolations may be suspected. It ordered two stones, one of 12 lb. and another of $12\frac{1}{2}$ lb., and to keep up the pretence of there being no weight other than of Tower standard, it declared that a pound shall contain 25 shillings. This shilling standard may be put aside.

The 12 lb. stone is ordered apparently either as a double of a customary 'lead-pound' of 6 lb. or to make the customary fotmal or 'pig' of lead, 70 lb. weight, 'contain 6 stones (of 12 lb.) less 2 lb.' It also says that the deduction of 2 lb. leaves '70 lb. making 5 stones.' This passage appears to be a subsequent interpolation after the institution of Edward III's 14 lb. stone.

The fother of lead, of 30 fotmals, would thus be = 2100 lb. But the stone of 12½ lb., evidently intended to be ⅛ of the true hundredweight, and to pave the way for the coming 14 lb. stone, is also applied to lead. How it is not said; but the present fother, = 2184 lb., is almost exactly equal to 30 fotmal, each of 73 lb. = 2190 lb.; and 73 lb. is just 6 stone of 12½ lb. less 2 lb.

The 70 lb. fotmal seems to have disappeared by the seventeenth century, but in the meantime the uncertainty of the fother led to the use of Boole-weight, meaning the weight used at the lead-boles or natural bowls in which lead ore was smelted. The fother, boole-weight, was 30 fotmals of 6 stone of 14 lb. Sometimes it was of 24 fotmals = 2016 lb., that is 18 cwt.

The meaning of Fother is given in Chapter XX.

6. Trade-units of Weight

It is unnecessary to describe or even name the various weights peculiar to trade or local custom. Everyone in the trade knows them; out of it no one need know them. If a person not in the trade buys a

cask of wine, a barrel of beer, a sack of flour or a load of potatoes, commonsense prompts him to ask how many gallons or pounds are contained in these units. It is the same in France and other countries of the metric system, where the cask, the sack, the churnful, &c., are trade-units with their peculiar equivalents of litres or kilogrammes. It is indeed by the use of trade-units that manufacturers evade the rigour of the metric system.

CHAPTER VIII

ENGLISH MEASURES OF CAPACITY

1. The Old Wine Measures

It has been seen that a cubic foot of water is very approximately = 1000 Roman ounces = $62\frac{1}{2}$ lb. of water at the early averdepois standard. There is reason to believe that this cubic foot was our original wine-unit, the wine-bushel, $\frac{1}{8}$ of it = 216 cubic inches, being the wine-gallon; and that the cubic foot, increased in water-wheat ratio $1728 \times 1{\cdot}25 = 2160$ c.i., was the corn-bushel. The corn-gallon, $\frac{2160}{8} = 270$ c.i., remained at this standard for centuries, 268·8 c.i. being the London measure, and $272\frac{1}{4}$ c.i. the Winchester measure, the slight differences being due to difficulties in casting and gauging shallow metal pans.

That the wine-gallon was originally $\frac{1}{8}$ cubic foot is rendered very probable by the existence in Ireland of a gallon of almost exactly that capacity. This gallon was legalised for ale, beer and spirits by George II (1735) at a capacity of 217·6 c.i.

The rise of the wine-gallon in England to 219 c.i., to 224 c.i., and finally to 231 c.i. under Henry VIII, seems due to two influences:

1. The desire to make it hold 8 lb. of wine = about 222 c.i., that weight being mentioned in statute.

2. The influence of wine-measures used at the ports whence wine came.

The principal unit of wine-measure at Bordeaux, and some other continental ports, was the Velte, the equivalent of the German viertel which was $\frac{1}{4}$ Rhineland cubic foot = 471·6 c.i. So our gallon tended to increase towards the measure of 235·8 c.i., the half-velte. It could not increase further than 231 c.i. without deranging its water-wheat ratio with the corn-gallon, already increased, temporarily at least, under Henry VIII to 282 c.i. But the principal reason for 231 c.i. was that this was the capacity of a cylinder 7 inches in diameter and 6 inches deep. It has always been desirable that market-measures should be of dimensions easily remembered and readily gauged with a foot-rule. The wine-gallon of 231 c.i., confirmed by the new measures made by Elizabeth's order, was afterwards known as Queen Anne's gallon. It is to this day the fluid gallon of the United States, Canada and Ceylon.

The half-velte was the French *galon*, a word connected with *galloie*, *jallaie*, *jalle*, *jarre*, with our 'jar' and with 'gauge,' Fr. *jauge*. It may be mentioned that 'velte' sometimes meant a gauging-rod for wine-casks.

The wine-gallon was divided into 2 pots, or 4 quarts or 8 pints. The wine-pint = 16·57 fluid ounces = $\frac{5}{6}$ Imperial pint.

Cask Measures

By 2 Henry VI (1423)—

The wine-Hogshead	was	63	gallons	
The Pipe	,,	126	,,	
The Tun (tonnel)	,,	252	,,	(12 score and 12).

Thus the hogshead (Flemish *okshoofd*, ox-head) was approximately $\frac{1}{4}$ of the tun or fluid ton.

252 wine-gallons of 8 lb. = 2016 lb.

The customary beer-barrel contained, and still contains, 36 gallons (now Imperial gallons). It is probable that it was originally a half-hogshead = $31\frac{1}{2}$ or 32 gallons, and that it rose as an indirect consequence of the statutory rise of the Cwt. and Ton. (This will be explained under Corn Measure.)

The half-barrel of 18 gallons was called a Kilderkin, from the old Flemish word *kinderkin*, a little child. To it corresponded the Runlet of $18\frac{1}{2}$ wine-gallons (1483), the German Eimer or double Anker.

The quarter-barrel of 9 gallons is a Firkin, a word in which *vierde*, a fourth, replaces *kinder*; so that in the fifteenth century it was a Ferdekyn.

But the ale-barrel remained nominally at 32 gallons, its kilderkin at 16, its firkin at 8 gallons. This counterbalanced the increase of the ale-gallon to 282 c.i. How did this rise come about? The probable explanation is that the ale-gallon was really a corn-gallon of Henry VII and VIII; it disappeared for corn, but it remained for ale.

2. The Ale-gallon

Henry III proclaimed on his accession that, according to Magna Charta, there should be but one standard of measure and of weight throughout the realm, one measure of wine, one measure of ale, and one measure of corn.

There seems to be no information extant about the second of these measures; it was presumably the same as the corn-gallon. A statute of Henry VIII ordered the barrel of beer to be 36 gallons and that of ale 32 gallons, whence it may be presumed that the former were wine-gallons and the latter corn-gallons, 32 and 36 being taken as the whole numbers nearly proportionate to wine and corn measure, and admitting of the quarter-barrel being 8 gallons of ale and 9 of beer.[1]

In 1496 (temp. Henry VII) a new corn-bushel was made = 2240 c.i., its gallon being 280 c.i. While it is possible that this increase was due to inaccurate casting, yet it might be that the new corn-gallon was intended to be on a water-wheat ratio with the wine-gallon, then = 224 c.i. ($224 \times 1\frac{1}{4} = 280$), in the same way that the usual corn-gallon of 270 c.i. was in that ratio to the original $\frac{1}{8}$ cubic foot gallon of 216 c.i. ($216 \times 1\frac{1}{4} = 270$).[2]

[1] For a long time the difference between ale and beer was that beer was hopped.

[2] It has been suggested that the 280 c.i. corn-gallon was constructed so as to have Averdepois-Troy ratio to the 231 c.i. wine-gallon (1·215 : 1). But the latter had not at the time risen to 231 c.i., and it is more probable that the ratio was that of water to wheat, the pound-pint ratio.

In 1531 the corn-gallon was increased to 282 c.i. But under Elizabeth the corn-gallon was restored to its old standard of $\frac{1}{8}$ bushel $= \frac{2150 \cdot 4}{8}$ c.i. $= 268 \cdot 8$ c.i. and the wine-gallon fixed at 231 c.i. At these standards both gallons stood until their unification in 1824. Confirmed by Queen Anne, they are known by her name.

But the corn-gallon of Henry VIII, = 282 c.i., remained as the Ale-gallon, probably because it had become the standard measure for malt.

The Quart and Pint

While the wine-pint was an eighth of a wine-gallon the common pint of England was the Ale-pint, an eighth of the Tudor Ale-gallon, which was 280 or 282 cubic inches and differed little from the Imperial gallon = 277·27 cubic inches. So the pint of ale in Tudor times differed little from an Imperial pint.

The Quart and Pint of Elizabeth preserved at the Standards Office are larger than Imperial measure, the Quart holding 40·53 ounces as compared with the 40 ounces of the Imperial quart; it is one-fourth of a gallon of 280 cubic inches, the Tudor ale-gallon.

3. Corn Measure

It has been seen that Henry III's statute defined the gallon as containing 8 lb. of wine, and Edward I's as containing 8 lb. of wheat. It is probable that the Magna Charta principle of 'one weight, one measure' prevented the mention of two different gallons, as it

prevented the mention of two different pounds. But we know that there were two gallons. In England as in ancient Greece the unit of corn-measure was the fluid measure of the Talent increased in water-wheat ratio; so our cubic foot, taken as a wine-bushel of 8 wine-gallons, and increased one-fourth, gave the corn-bushel of 8 corn-gallons.

$\frac{1728}{8}$ c.i. = 216 c.i., the original wine-gallon,
1728 c.i. × 1·25 = 2160 c.i., the corn-bushel,
of which $\frac{1}{8}$ = 270 c.i. was the corn-gallon.

It has been seen that the wine-gallon increased to 231 c.i., but the corn-standard remained for centuries (excepting a vagary temp. Henry VII and VIII) at very nearly its original value. It must be remembered how difficult it must have been to cast accurately a shallow brass pan 18½ inches in diameter and only 8 inches deep; and this is probably the cause of the slight difference between the two standards of corn-measure, the London bushel and the Winchester bushel. These were simply variants, inevitable in making standard measures of the calculated capacity of the bushel = 2160 cubic inches = 1¼ cubic feet.

The London bushel = 2150·42 c.i.; the gallon = 268·8 c.i.

The Winchester bushel = 2178 c.i.; the gallon = 272¼ c.i.

The latter standard was so called, it is said, because its standard had been kept at Winchester since the time of King Edgar; it was, by 22 Chas. II (1670) and 10 Geo. III (1769), the standard measure for corn and other dry goods.

But by 13 Wm. III (1702) and by 5 Anne (1707) the London bushel was the standard, and this is the present corn-bushel of the United States. It is, however, commonly called, but inaccurately, a Winchester bushel.

4. The Quarter and the Chaldron

When the Cwt. was raised to 112 lb. and the Ton to 2240 lb. the Chaldron or ton-measure of wheat was increased by statute from $4 \times 8 = 32$ bushels to 36 bushels. One would think it would follow that the Quarter would be raised from 8 to 9 bushels. No, it was not raised, by law at least; so the corn-trade raised it themselves, thinking that evidently if a chaldron is now 36 bushels, for the quarter of it we must ask or give 9 bushels.

But this practice was apparently held to be an offence against the repeated royal declarations beginning with the 32 wheat-corn weight of the penny and ending with the 'bushel which is the eighth part of the Quarter.' While one statute raised the Chaldron to 36 bushels, another declared that its quarter was to remain at 8 bushels. In 15 Rich. II (1391) it is declared that '8 bushels striked should make the Quarter of corn nevertheless that divers people will not buy but 9 bushels for the Quarter.'

As statutes of 1436 and 1496 repeated this prohibition of any increase of the quarter one may presume that the forbidden practice continued, the increased quarter being called a Vat. But there was another way of evading these statutes; the old story with bad

legislation ; *Fatta la lege, trovato l'inganno.* It became in many parts customary to give, not a long-quarter, but a long-bushel of 9 gallons, so that 8 long-bushels would make the new quarter-chaldron. It was possibly a relic of this practice which caused the Chester corn-measure to become 70 lb., roughly $62\frac{1}{2}$ lb. $\times \frac{9}{8} =$ 70·3 lb. Cheshire perhaps benefited by its neighbourhood to Lancashire, which was specially exempted by 13 Rich. II from the penalties for offences against the unity of weights and measures, 'because in that county it hath always been used to have greater measure than in any other part of the realm.'[1] Yet long-bushels are sometimes the striked equivalents of heaped measure.

But in most parts of the country the attempts to correct stupid legislation were abandoned, and so the Chaldron of 36 bushels fell almost out of use and the Quarter ceased to be a quarter of any measure. In 1707 Bishop Fleetwood ('Chronicon preciosum') could only say 'doubtless a Quarter is a quarter or fourth part of some load or weight.' And there is a story that Lord Kelvin, asking the head of the Standards Office (giving evidence before a Royal Commission on Weights and Measures) of what a Quarter was the quarter, failed to obtain any light on the subject. And he himself did not know.

But since the corn-trade brought back from North America the old ton of 20 centals, the quarter has found

[1] Curiously Lancashire still uses the Cheshire acre, and in some parts a pound of butter is a pound + the weight of 2 pennies, formerly the heavy Georgian ounce-pennies, now the lighter bronze coins.

its long-lost father. The freight-ton of ships, 40 cubic feet of cargo, contains 32 bushels (at $1\frac{1}{4}$ cubic feet to the bushel), that is 4 Quarters or 2000 lb. of average wheat = 20 centals.

5. Coal Measure

The Chaldron of 36 bushels is used for the sale of coke and in Northumberland for coal.

A ‘keel’ of coal, i.e. the load of the Tyneside lighter known as a ‘keel,’ was, up till the fifteenth century, 20 ‘chaldres,’ the measure of 20 old tons:

The old chaldron of wheat, 32 bushels of $62\frac{1}{2}$ lb. = 2000 lb.
,, ,, ,, ,, coal, 25 ,, ,, 80 lb. = 2000 lb.

When the old Chaldron became illegal it gradually gave place to the new ton and to the new chaldron. The Newcastle chaldron was 2 statute chaldrons = 72 bushels. The modern keel of coal is 21·2 tons = 16 statute chaldrons of 36 bushels = 8 Newcastle chaldrons. This double chaldron is then 72 bushels, or, as $\frac{1}{8}$ of the keel, = 21·2 tons, it is 53 cwt., and it is divided into 3 Fother of $17\frac{2}{3}$ cwt. = 1966 lb. or nearly the old ton of 2000 lb. Thus the Newcastle fother is nearly the old ton, and the keel of 24 fothers or old tons has taken the place of the sixteenth-century keel of 20 old tons.

In the eighteenth century the coal-bushel was slightly changed from London or Winchester standard. 12 Anne (1714) ordered a special coal-bushel. It was defined as containing a Winchester bushel and a quart, 33 instead of 32 quarts = 2218 cubic inches, and coal was to be sold by the chalder of 36 such bushels, heaped.

This new bushel was $\frac{1}{8}$ inch more in diameter and in depth than the old standard; it arose probably from a faulty casting. It is remarkable, inasmuch as its capacity is almost exactly that of the Edinburgh firlot and also of the Imperial bushel instituted a century later.

The Chaldron survives for coke. When coal is coked at the gas-works it swells, so that a ton of coal, = about $\frac{3}{4}$ chaldron, yields about a chaldron of coke.

Heaped Measure

It has been seen that in 1392 the bushel was to be measured 'striked' and not heaped. Yet the love of extra weight or measure is so ingrained in human nature that it persisted, at least in retail transactions. With a pan-shaped bushel more than twice as broad as deep, heaping increased the measure by not less than one-fourth. With a drum-shaped bushel, its depth equal to its diameter, the increase of heaped over striked measure would be about an eighth, so that a bushel of wheat would weigh about 70 lb. instead of 62 lb. Heaped measure was made illegal in 1835.

It is possible that some long-bushels (as that of Chester = 70 lb.) were originally, or actually, heaped bushels.

6. The Imperial Gallon

In 1824 some of our measures were reorganised, and among the changes was the unification of wine and corn measure. The better concordance of capacity

with weight by a single gallon containing exactly 10 lb. of water at ordinary temperature has been a great advantage. It has enlarged the decimal capabilities of our system without impairing its convenient and popular series of capacity units. It is indeed an advantage that the slight increase of the corn-gallon now gives a weight of 64 lb. good wheat to the bushel, so that the pint corresponds very exactly to a pound of wheat.

Yet it must be remembered that our brethren of the United States, not usually deemed unprogressive, get on very well with Queen Anne's wine-gallon and corn-gallon.

The new gallon holds exactly 10 lb. of pure water at 62° or 277·274 cubic inches.

The bushel is of the capacity of 2218·19 cubic inches. It holds 80 lb. of pure water.

The change from the old corn-gallon was very slight, increasing it by only 3 per cent., from 268·8 to 277·27 c.i. (and rather less from the Winchester gallon of 270 c.i.), so that the bushel formerly holding 62½ lb. of wheat now holds 64 lb.

Wine-measure was increased by almost exactly 20 per cent., from 231 c.i. to 277·27 c.i., so that a gallon of wine is contained in 6 customary bottles, instead of 5 as formerly, or as at present in the United States.

Bushel measures are of two shapes: the drum-shape, 15 inches diameter by 12¾ inches deep, and the standard shape (that of the old corn-measure), 18½ inches diameter by 8¼ inches deep.

Nothing has been changed in the excellent octonary series of measures, pint, gallon, bushel, quarter (eight

of the first making one of the second and so on), with binary sub-units—some of them general, as the quart; others local, as the coomb; and some more or less obsolete, as the tuffet, famous in nursery rhyme.

MEASURES OF CAPACITY

2 Noggins	1 Gill		(In the South 4 gills to a pint)	
2 Gills	1 Pint		20 oz. water	1 lb. wheat
2 Pints	1 Quart			
2 Quarts	1 Pottle	8		
2 Pottles	1 Gallon		10 lb. water	8 lb. wheat
2 Gallons	1 Peck			16 lb. wheat (old stone)
2 Pecks	1 Tuffet	8		
2 Tuffets	1 Bushel		80 lb. water	62–64 lb. wheat
2 Bushels	1 Strike			
2 Strikes	1 Coomb	8		256 lb. wheat (16 old stone)
2 Coombs	1 Quarter			500–512 lb. wheat
4 Quarters	1 Corn-ton			40 cubic feet

These measures can be used for either dry goods or fluids. The smaller measures below a pint are used for fluids.

Fluid Measures

The institution of the Imperial gallon, while increasing corn-measure by 3 per cent., had less effect on Ale-measure. The Ale-pint, being $\frac{1}{8}$ of the Ale-gallon of 282 cubic inches, was somewhat larger than the new Imperial pint, holding about $20\frac{1}{4}$ ounces; so the change to the Imperial pint of 20 ounces was practically imperceptible.

The Gill is officially, according to southern custom, a $\frac{1}{4}$ pint; but in Lancashire and the north it is a half-pint. The name Gill, like the Jug synonym for Pint, is part of a popular series of names for beer

or spirit measures. Jug is the feminine of Jack, with which name Gill is familiarly associated.

Pint or Jug		20	ounces
$\frac{1}{2}$,,	,, Gill (in the north)	10	,,
$\frac{1}{4}$,,	,, Jack (or Noggin)	5	,,
$\frac{1}{8}$,,	,, Jock (a dram)	$2\frac{1}{2}$	,,
$\frac{1}{16}$,,	,, Joey	$1\frac{1}{4}$	,,

The customary capacity of wine-bottles is $\frac{1}{6}$ gallon = $26\frac{2}{3}$ ounces. So six customary bottles go to the gallon, and a customary 'dozen' of wine or spirits = 2 gallons.

In India the gallon of canteen-spirit, rum or arrack, is reckoned as 48 drams, each $\frac{1}{8}$ bottle or $3\frac{1}{3}$ fluid ounces.

7. Medicinal Fluid Measures

The Imperial gallon, as 10 lb. of water = 160 fluid ounces, each of $437\frac{1}{2}$ grains of water at standard temperature.

Its eighth part, the Pint, contains 20 ounces weight or 20 fluid-ounces measure. It is so divided on druggists' glass measures. The fluid ounce is divided into 8 fluid drachms, each of 60 minims, approximately fluid grains.

In the United States, where the old wine-gallon of 231 cubic inches is retained, the old wine-pint of 16 fluid ounces is used. 231 c.i. × 252·458 (grains of water in 1 c.i.) gives—

58,317·8	grains for the gallon
7,289·7	,, ,, ,, pint
455·6	,, ,, ,, ounce

The fluid ounce is divided as in England into 8 fluid drachms, of 60 minims.

CHAPTER IX

THE MINT-POUNDS

1. The Saxon or Tower Pound

At some time before the Norman Conquest the Marc of Cologne was brought to England, probably only as the mint-standard of the later English kings, for the 16-ounce Roman pound was already long-established as the commercial weight.

The standard of the Cologne marc has never varied much.

Its mean weight = 3608 grains; when doubled it made a pound = 7216 grains, with an ounce = 451 grains. This pound is almost identical with the greater rotl of Al-Mamūn, $\frac{1}{100}$ of the cantar = 102·92 lb.; and the old Prussian pound of Cologne standard was $\frac{1}{100}$ of the Prussian centner = 103·11 lb.

The Norman Conquest made no change; the Saxon pound became the Tower pound, the King's treasury or mint being in the Tower of London. The Tower pound of standard silver was coined into 240 silver pennies, which, at $22\frac{1}{2}$ grains, their weight down to the time of Edward III, gives 5400 grains for the pound and 450 grains for the ounce. An actual weight

= 5404 grains was found in the Pyx chamber in 1842.

The shilling, of 12 pence, was until Tudor times only money of account. But it was also a weight of account, the pound being either 12 ounces of 20 pennyweight, or 20 shillings of 12 pennyweight.

'When a quarter of wheat is sold for 12 pence, the wastel-bread of a farthing shall weigh 6 li. and 16 s. But bread cocket of a farthing shall weigh more by 2 s.' (Assize of Bread, 51 Henry III.) That is, the farthing loaf shall weigh $6\frac{1}{2}\frac{6}{0}$ Tower lb. = $5\frac{1}{4}$ averdepois lb., and the second sort 24 dwt. or $1\frac{1}{5}$ Tower ounce more.

Here is an instance of the confusion caused by making bread, like gold, silver and medicines, saleable only by the royal pound. This system of a peculiar pound for bread lasted till the eighteenth century.

Under Edward I the halfpenny loaf weighed 40 s., that is 2 lb. Tower = a little more than $1\frac{1}{2}$ lb. averdepois.

Moneyers and goldsmiths divided the dwt. or original weight of the silver penny, for fine weighing, on the Dutch system, that is into 2 mayles, 4 ferlings 8 troisken, 16 deusken, 32 azen (aces). This would account for the 32 wheat-corns which the silver penny was always supposed to weigh, however many pence the mint struck from the pound of silver.

The mayle and ferling (Fr. *maille* and *felin*) were the mint-names for the silver halfpenny and farthing.

Under the gradual influence of Troy weight the dwt. Tower was also divided into 24 parts or grains. It was so divided in the time of Edward III.

It must be remembered that there was absolutely no definition of Tower weight, nothing but the usual proclamation about the 32 wheat-corns, a convenient definition, as they still appeared to balance the penny when it had fallen to half its original weight.

2. The Troy Pound

The pound of Troie is mentioned in the time of Henry IV, and in the next reign goldsmiths were ordered to use *la libre de Troy*, though by 9 Henry V mint-rates were still stated in *la libre de Tour*. By 2 Henry VI the price of standard silver is fixed at 30*s*. la livre du Troie, which means that 12 × 30 pennies of 15 grains were being coined from a pound of 5400 grains, evidently still a Tower pound. Notwithstanding the change of name, the Troy pound was not proclaimed as the royal pound until 1527, when by 18 Henry VII 'the pounde Towre shall be no more used, but all manner of golde and sylver shall be wayed by the pounde Troye which excedith the pound Towre in weight 3 quarters of the ounce.' But the Troy pound had been used concurrently with the old mint-pound for a long time, and there had been two standards at the mint.

According to an anonymous writer in 1507 (quoted in Snelling's 'View of the Silver Coin and Coinage,' 1762) 'it is a right great untruth and deceit that any such pound Toweres should be occupied, for that thereby the merchant is deceived subtilly and the mint master is thereby profited.'

There is no doubt that after the conquest of England by Henry Tudor a cloud of deceit came over the coinage, deceit only ended by Elizabeth's establishment of the coinage on an honest basis. Comparing the declaration of weights, measures, and coinage by Henry III in 1266 with that of 12 Henry VII in 1496, the latter does not show to advantage. It orders—

> That every Pound contain 12 ounces of Troy weight and every ounce contain 20 sterlings and every Sterling be of the weight of 32 corns of wheat that grew in the midst of the ear according to the old law of the said land.

Meanwhile the Troy ounce of silver was being coined, not into 20, but into 40 sterlings or pennies. But each of these was supposed to weigh 32 wheat-corns just as they did when they were really 20 to the ounce, albeit a Tower ounce.

Whence came the Troy Pound?

It is probable that the name of the King's Troy pound came from the marc of Troyes, but it is certain that the English Troy pound no more came from Troyes than the 'pound Toweres' came from Tours.

There were four principal marcs in France:

Marc de Troyes	its oz.	= 472·1	grains
„ „ La Rochelle	„	= 443·4	„
„ „ Limoges	„	= 436·5	„
„ „ Tours	„	= 430·9	„

The marc of Troyes doubled made the livre poids de marc, the Paris standard = 7554 grains.

That of La Rochelle, the marc d'Angleterre, would appear from its name to have been, originally at least, the marc of Cologne, Tower standard, but its standard corresponds almost exactly to the marc of Castille. I make inquiries at La Rochelle, and am informed that the La Rochelle mint had at one time been coining for Spain, perhaps at the time of Plantagenet dominion in the South.

The marc of Limoges coincides nearly exactly with 8 ounces averdepois of Plantagenet times; it will be remembered that Limoges was for a long time an English Plantagenet city.

The marc of Tours is of southern rather than northern type.

None of these marcs seem to have any relation with the Troy weight of England.

There appears to have been in Northern France, England and Scotland, about the eighth century, a heavy 16-ounce pound of nearly 8500 grains, possibly related, through the Russian pound, with the miná of the Greek-Asiatic talent = 8415 grains. This was probably the heavy pound which survived in Guernsey up till the eighteenth century; and perhaps other pounds said to be of 18 ounces, such as that of Cumberland up to a generation ago, were really survivals of this heavy northern pound. Whether this pound dwindled spontaneously, or whether it was superseded by the pound derived, either directly from the lesser Arabic rotl with an ounce = $480\frac{1}{4}$ grains, or indirectly

from an ounce of 10 dirhems, of about 48 grains, is difficult to say. All that is known is that there is a family of pounds usually known as Troy with an ounce varying between 483 and 472 grains; that the pennies of Charlemagne averaging 25 grains correspond to an ounce of about 500 grains, possibly more, which is certainly not modern French Troy, and that many Saxon pennies of about that time were much heavier than those of the times nearer to the Conquest. The Northern Troy pounds show the following variations:

Swedish mark-weight pund,	its ounce	= 483·3	grains
Danish solvpund	,,	= 481·5	,,
Scots Tron pound	,,	= 481·1	,,
Bremen pound	,,	= 480·8	,,
Norwegian skaalpund	,,	= 477·4	,,
Amsterdam pound	,,	= 476·6	,,
Scots Trois ,,	,,	= 475·5	,,
Dutch Troy ,,	,,	= 474·7	,,
French Troy ,,	,,	= 472·1	,,

The variation in these Troy pounds seems due to their ounces being 10 dirhems of 48 grains, more or less; the lightest ounce, that of French Troy, being 10 dirhems of 47·1 grains, the same as the dirhem of which the Provençal ounce, 377 grains, contained 8.

Our Troy pound, while taking its name, like the Scots and Dutch pound, from the Troyes marc, took its standard from some pound of full weight, possibly from the Bremen pound, introduced by the Hanse merchants. Its exact standard appears due to the influence of the averdepois pound, and this would explain—

How the Averdepois Pound was of 7000 Grains.

This division into 7000 grains was not arbitrary, but it was due to the desire to give it as simple a ratio as possible to the new Troy pound. It was found by a Parliamentary Committee in 1758 to weigh 7000 of those grains into which the Troy pound had always been divided, necessarily into 5760 of them (12 oz. × 20 dwt. × 24 grs.). Now it seems probable that when the Troy pound was adopted for mint purposes its weight might be modified, on the advice of goldsmiths and merchants, so as to give it a convenient relation to the old-established averdepois pound. Supposing the new pound were of the Bremen standard, 7693 grains, of which 12 ounces = 5769·6 grains, then its weight would be to that of averdepois as 5769·6 to 7000, or as 5760 to 6987·8. To make the proportion 5760 to 7000 it would be necessary to decrease the weight of the Troy pound by about 8 grains or to increase that of the averdepois pound by about 10 grains. It is probable that the latter alternative was adopted, and that the averdepois pound was raised in such proportion that it now weighed 7000 grains of the Troy pound = 5760 grains. This accounts for the rise in the weight of the averdepois standard between Plantagenet and Elizabethan times, making the ounce = 437½ grains instead of the 437 grains of the Roman ounce.

It is not improbable that the change of mint-standard from Tower to Troy was due to the very inconvenient ratio of the Tower pound to the averdepois

pound. The mint-pound being necessarily divided into 12 ounces of 20 pennyweight of 24 parts or grains = 5760 parts, the ratio of the Tower and averdepois pounds was 5400 to nearly 7000, or 5760 : 7453, the latter figure being about the number of Tower grains = 0·937 grain, contained in the original averdepois pound. The introduction of a new pound, which by slight modification in either it or the averdepois pound would give the simpler ratio of 5760 to 7000, would probably be most welcome to the mercantile community.

In Teutonic countries the usual system of dividing the pounds was as follows:

Mint-marc of 8 oz. × 20 dwt. × 24 grs. (or 32 azen). Oz. of 480 grains.

Medicinal lb. of 12 oz. × 24 scruples × 20 grs. Oz. of 480 grains.

Commercial $\begin{cases} \text{Marc of 16 loth} \times \text{16 ort (German).} \\ \text{lb. of 16 oz.} \times \text{16 drams (English).} \end{cases}$

The Latin nations followed the ancient Roman system of dividing the ounce:

Mint-pound of 12 oz. × 6 sextulæ × 24 siliquæ = 1728 siliquæ, the ounce being of 6 × 24 = 144 siliquæ or carats, and the carat of 4 grains, giving 576 grains in an ounce.

Medicinal lb. of 12 oz. $\begin{cases} \times \text{ 8 drachmæ} \times \text{ 3 scrupuli} \times \text{ 24 granæ,} \\ \times \text{ 8 drachmæ} \times \text{ 3 scrupuli} \times \text{ 2 oboli} \times \text{ 12 granæ.} \end{cases}$

In Southern France:

Pound of 16 oz. × 8 ternau × 3 denié × 24 gran.

There we see the scruple becomes a pennyweight, and the obolus or half-scruple becomes a halfpenny.

In Northern France :

Mint-marc 8 oz. × 8 gros × 3 deniers × 24 grains.
Medicinal lb. of 12 oz. × 8 drachmes × 3 scrupules × 24 grains.
Commercial lb. of 16 oz. × 8 gros × 72 grains.

In this system, common to France, Spain, Portugal, Florence, and Rome, the ounce is divided into 576 parts or grains, while the Troy ounce of the rest of Europe is of 480 grains. This makes the Latin grain lighter.

In the medicinal pound, more or less international throughout the West, the 24 Scruples of the ounce are grouped into 8 drachms of 3 scruples.

It may be concluded that the English Troy pound was a Northern weight with its ounce of 480 instead of 576 parts. It has no direct connexion but in name with the marc of Troyes. It probably came to us as an apothecary's and goldsmith's pound, and in the latter, the Latin factors 24 scruples × 20 grains were transposed for mint purposes so as to preserve the ancient pennyweight $\frac{1}{20}$ ounce of the Tower pound. But in the apothecary's Troy pound the ounce remained divided into 24 scruples (8 drachms of 3 scruples) each of 20 grains as in other countries except France, &c.

The story of the goldsmiths' Carat and Grain will be found in Chapter XX, that of the Provençal weights, from which the French Troy was derived, in Chapter XVIII.

3. The Pride and Fall of Troy

The myth of the 32 wheat-corns which formed the basis of the Tower pound = 5400 grains, passed to the Troy pound = 5760 grains, and this deliberate fiction lasted till the time of Elizabeth and perhaps later. It did little harm as regards these mint-pounds, but its application to the Averdepois pound, alleged to be an offshoot of the royal pound, either as 25 shillings, that is 300 pennyweights of 32 wheat-corns, or as 15 ounces Troy, or at a later period as 16 ounces Troy, produced a mental obliquity which is most lamentable.

The jury of merchants and goldsmiths appointed in 1574 to examine the ancient standards, and construct a new set, declared that ' the one sorte of weight nowe in use is commonlie called the troie weight and that other sorte thereof is also commonlie called the avoir de poiz weight, and further they say that both the saide consiste compounded frome thauncient Englishe penye named a sterling rounde and unclipped which penny is limeted to waie twoo and thirtie grains of wheate in the midest of the eare and twentie of those pence make an oz. and twelf of those ounc make one pound troie.' They go on to ' saie that the said twoo sortes of weights doe differ in weight the one from the other three ounces troie at the pounde weight, for the pounde weight troie doth consiste onlie of xii oz. troie and the lb. weight of avoir de poiz weight dothe consiste of fiftene ounc troie.'

Thomas Hylles, in his ' Arte of Vulgar Arithmeticke '

(1600), showed himself emancipated from the superstition of troy weight so far as to say:

'15 ounces of Troy weight should by the statute make 1 pound of haverdepoise, but the same pound weyeth commonly but 14 ounces $\frac{1}{2}$ Troy, 14 ounces $\frac{3}{5}$ at the uttermost.'

($14\frac{1}{2}$ oz. troy = 6960 grs.; $14\frac{3}{5}$ oz. = 7008 grs.)

But he unfortunately went on to say that 'of things liquid and dry 1 pound of Troy weight maketh a pinte in measure,' not seeing that 12 oz. troy = only 13·16 oz. averdepois, while a wine-pint contained $16\frac{2}{3}$ ounces of water, and a corn-pint close on 16 ounces of wheat or 20 of water.

But the ignorance and superstition engendered by troy weight was just as bad in 1702 as in 1600 or even in 1500, as shown by the following utterance of an eighteenth-century scientist:

Troy weight, whereby bread, gold, silver, apothecaries' wares etc. are weighed containing only 12 ounces in the pound, each ounce 20 pennyweight each pennyweight 24 grams. This seems to have been the most ancient weight by its name, as derived from the famous city of Troy, from whence Brutus and his people are said to have descended and to have called London Troy-Novant or New Troy.

So said J. Ralphson, F.R.S., in his 'Mathematical Dictionary' (London, 1702). And then he continued:

The second and more common weight is called Avoirdupois, being fuller and larger weight than the other, for it contains 16 ounces or 128 drams, viz. 384 scruples, viz.

7680 grains, by this are weighed all kinds of grocery ware and base metals, as iron, copper and brass, as also hemp, flax, rosin, pitch, tar &c.

A century later we find not much improvement in the idea of the pounds Troy and Averdepois.

'The pound or 7680 grains avoirdupois equals 7000 grains troy and hence 1 grain troy equals 1·097 avoirdupois' (Rees' 'Encyclopædia,' 1819). This is an example of the utter muddle the Troy pound had made in the minds of otherwise intelligent people.

Similar pedantic efforts were continued, well into the nineteenth century, to represent the Troy pound as the sole standard of England and the averdepois pound only respectable as an offshoot of the royal pound used for vulgar purposes.

The Assize of Bread

Such fictions were helped by the old statutes which compelled the sale, first by Tower and then by Troy weight, of bread as well as of gold, silver, and medicines. And confusion was made worse by the use for a long period of a third weight for bread, the Amsterdam or Scotch troy pound.

The peck loaf, supposed to be that produced from a peck of flour (16 pints), was to weigh 16 of these pounds = 17 lbs. 6 oz. averdepois, the quartern loaf 4 = 4 lb. 5 oz., and the pint loaf (to be sold at a penny when wheat was 4*s*. a bushel or 32*s*. a quarter) was to weigh one pound = 17 oz. 6 drams averdepois. The periodical Assize of Bread fixed the price of the peck loaf.

It appears then that the pound of bread was = 7600 grains, its ounce = 475 grains, which was about the Scottish (and Dutch) troy standard. It was probably adopted as coinciding with the weight of bread supposed to be produced from a pint of flour and as keeping up the old superstition that bread must be sold by troy weight. As some persons in authority did not share the stupidity of those who considered the averdepois pound to be 16 troy ounces, the Scottish 16-ounce pound of troy standard was imported for the purpose.

This weight was abolished by 8 Anne (1710) and the sliding scale was put in the averdepois equivalent.

The Assize of Bread was abolished in 1815, but traces of it remain in the name 'quartern loaf,' although this now means a loaf of 4 imperial pounds. It may also mean a loaf weighing the quarter of a 16-lb. stone.

The Disappearance of the Troy Pound

In 1841 a Royal Commission on Weights and Measures recommended the abolition of the Troy pound as 'wholly useless,' retaining its ounce provisionally for the use of bullion merchants, pending 'the removal of the troy scale.' This recommendation was not carried out until 1878, when the Troy pound disappeared, except of course in almanacks and books for the instruction of youth—but the Troy ounce still survives at the mint, and consequently in the bullion market; and it is virtually forced on druggists in spite of the

Medical Council. Troy weight was abolished by the Pharmacopœia Committee in 1864, Imperial weight being alone recognised ; yet the Board of Trade keeps up the Apothecaries' ounce of 480 grains. Troy weight has fallen ; but, like many other superstitions, it dies hard.

CHAPTER X

THE CUBIC FOOT AND THE TON REGISTER

THE cubic foot and the cubic inch are the usual measures of solidity. The cubic yard is used as a measure of masonry, earthwork, or reservoirs of water.

The cubic foot has many points of concordance with weights and with measures of capacity, and is the basis of ship and cargo measurement.

The definition of the Imperial gallon as 277·274 cubic inches, the volume of 10 lb. of water at 62°, a pound of water measuring 27·7274 cubic inches, led to attempts to determine accurately the weight of a cubic inch and of a cubic foot of water. These experiments are interesting in consequence of the recognition, in 1685,[1] that the cubic foot of water weighed approximately 1000 ounces, and of the probability that this weight of water in Roman ounces, = 437 grains, was the source of our Imperial system. It has already been shown how difficult it is either to construct accurately a measure containing a certain weight of

[1] 'Some Gentlemen at Oxford in 1685 determined the weight of a cubic foot of spring water, or 1728 solid inches, to be 1000 ounces averdepois.'—Kelly, *Metrology*, 1816.

water or conversely to determine the weight of water in a standard measure.[1]

The statute definition of the cubic inch of water as = 252·458 grains at 62° corresponds to 62·326 lb., or 997·21 ounces, for the cubic foot. Reduction of these weights to the standard of maximum density of water at 39·2° increases the weight of the cubic inch by 0·29 grain, and of the cubic foot by 1·1 ounce, making it = 62·4 lb. or 998·3 ounces. An Order in Council of 1889 gives 252·286 grains as the weight of the cubic inch of water. But the exact weight is uncertain, and the 1824 statute definition seems to be as accurate as the more recent determinations, all different.

It may be taken that the cubic foot of water weighs very approximately—

at 62° in air	997·2 ounces	
at 39·2° in air	998·3 ,,	(+ 0·9 ounce)
at 39·2° in vacuo	999·6 ,,	(+ 2·4 ,,)

And 1000 ounces of water at the original weight of the averdepois ounce, of Roman standard = 437 grains, would weigh 999·5 of such ounces, at 62° in air.

Practically measures of capacity need only approximate coincidence with standards; they are used for

[1] For this reason the custodians of the metric system have abandoned the cubic decimetre of water as the basis of measures either of capacity or of weight. The kilogramme is now, like our pound, a certain metal standard, and the litre is a measure containing, more or less exactly, a kilogramme of water. A perfect litre standard contains 1000 grammes of water at 39·2°; but 1·1 gramme less at 62°, 2 grammes less at 70°, and 3·3 grammes less at 80°, a very frequent summer temperature. For exact correspondence of measure with weight, corrections are always required whether on the imperial or on the metric system.

convenience in order to avoid weighing, especially in retail trade. Corn and many other kinds of produce are more conveniently measured than weighed, the average weight being ascertained, if desired, by a sample bushel.

Fluids may also require corrections for temperature when bought or sold by measure. Water increases in volume 1 per 1000 between 39° and 61°; and another 1 per 1000 between 61° and 70°; other fluids have their peculiar coefficients of expansion.

Allowing then for small temperature-corrections, the cubic foot may be taken as equal to 62½ lb. or 1000 ounces of water, and at this sufficiently approximate standard it becomes the basis of a series of measures for ship and other purposes.

The Ton Register

The capacity of ships has for centuries been reckoned in tons. The term arose from the custom, in French and other wine ports, to take as the unit of cargo-bulk the tun of wine usually contained in four hogsheads, each of 63 wine-gallons. The number of hogsheads divided by 4 gave the tonnage to be charged.

This cargo-ton, the *tonneau d'encombrement,* was equal to 42 French cubic feet = 51 English cubic feet.

The Ton Register appears to have arisen in the ports of Northern Europe. There the unit was usually the skippund (ship-pound) of about 360 lb. for wool and light goods. But the Last was also a wide-spread, though variable, measure; in the Baltic

trade it was usually reckoned at 11¼ quarters of wheat = 90 bushels or 5400 lb. In England it was usually 10 quarters = 80 bushels = 5000 lb. Now this bulk of wheat measures about 100 cubic feet, so 100 English cubic feet has become the unit adopted in all maritime countries, as the Ton Register. In France it is called the *tonneau de jaugage* and is taken as = 2·83 cubic metres.

A ship of 2000 tons register is of a capacity = 200,000 cubic feet below decks. The register tonnage is thus obtained:

Mean length × 0·94 of maximum beam × depth from upper deck to keel, the measure being taken inside, and in feet. The product is cubic feet, which divided by 100 gives register tonnage.

In France these measurements have to be made in metres; the product in cubic metres is divided by 0·38 to get tonnage.

Net tonnage, as distinguished from gross tonnage, is the latter less the space occupied by cabins below deck, by engines and bunkers, in short all that is not 'hold.'

This deduction gives the space available for cargo, a very large proportion in a sailing-ship, a very small proportion in a steam-yacht or tug.

The Cargo Ton is usually reckoned at 40 cubic feet; the space occupied by 20 centals = 4 quarters of wheat, or 25 centals of water.

A steamship of 4500 tons register may be 3000 tons net; as each of these net tons will contain 2½ tons of cargo of about the same weight as wheat, after

allowing for cases, dunnage, &c., the ship may be described as carrying 7500 tons dead-weight. Of course, this would only apply to goods of medium weight; not to iron rails or to ore, which could only be taken as a limited part of the cargo, the rest of the space being either filled with light goods or remaining empty.

The ship-owner has the choice of charging freight by measurement, usually at 40 c. ft. to the ton, or by the ton weight for metal and other heavy goods.

Concordance of Capacity, Weight and Measurement

Capacity	Weight of Water			Cubic Inches	Weight of Wheat Lb.	Cubic Feet
	Oz.	Lb.	Oz.			
			1	1·73		$\frac{1}{1000}$
(½ Quartern)	2½					
			10			$\frac{1}{100}$
× 8 = Pint	20	= ·1¼		34·6	1	
			100		5	$\frac{1}{10}$
× 8 = Gallon	160	= 10		277¼	8	
		62½	1000		50	1
× 8 = Bushel		80		2218	64	
					Cental 100	2
× 8 = Quarter					500	10
× 4 = Ton-cargo					2000	40
= Ton-register					10 Qrs. 5000	100

With the Corn-bushel (U.S.) = 62½ lb. of wheat, 1 Quarter = 500 lb.
" " Imperial bushel = 64 lb. " 1 " = 512 lb.

TABLE OF VOLUME AND WEIGHT OF WATER AT DIFFERENT TEMPERATURES

Temperature Fahr. °	Expansion — 1000 Units of Volume	Density — 1000 Units of Weight	Weight of 1 Cubic Foot. Ounces	Corrections from 1000 ozs. in 1 Cubic Foot.
32	1000·13	999·8	998·1	
39·2	1000	1000	998·3	— 1·7 oz.
45	1000·1	999·9	998·2	— 1·8 ,,
50	1000·25	999·75	998	— 2 ,,
55	1000·55	999·4	997·7	— 2·3 ,,
60	1000·9	999·1	997·4	— 2·6 ,,
62	1001·1	998·9	997·2	— 2·8 ,,
65	1001·5	998·6	996·8	— 3·1 ,,
70	1002	998	996·3	— 3·7 ,,
75	1002·6	997·4	995·7	— 4·3 ,,
80	1003·3	996·7	995	— 5 ,,
85	1004	996	994·3	— 5·7 ,,
90	1004·8	995·2	993·5	— 6·5 ,,
95	1005·7	994·3	992·6	— 7·4 ,,
100	1006·8	993·2	991·5	— 8·5 ,,

CHAPTER XI

SCOTS, IRISH, AND WELSH MEASURES AND WEIGHTS

1. Scotland

The Scots system was distinctly North German, influenced by English measures.

Linear Measures

The standard of length was the Scots Ell = 37·06 English inches. Originally three Rhineland feet at 12·353 inches, it was always described as containing 37 inches. The inch, at $\frac{1}{37}$ of the ell, was slightly longer, by less than 2 in 1000, than the English inch. The penalty edicted in 1685 against the use of any other foot but that of 12 inches, while 'three foot and an inch' were a Scots ell, seems to show that a foot equal to one-third of an ell may have been used.

The rod or 'fall' was 6 ells; the acre was 160 square rods = 1·26 acre, and very nearly equal to the French arpent, which was equal to the Roman heredium. This is, however, a mere coincidence. The Scots acre comes, like the English acre, from North Germany. The type of the Scots acre is seen in the Jück (yoke) of Oldenburg; this field-measure is 160 square ruthen;

each ruthe is 18 feet square, presumably 18 Rhineland feet = 6 Scots ells, originally; though now of a lower standard which makes the Jück = only 1·12 acre instead of the 1·26 acre of Rhineland standard.

Weights

There was an ancient weight, the Tron pound, of variable standard, about 20 Scots ounces. But its actual weight appears to have been 9622 grains, which is exactly 20 ounces of the original Arabic ounce = 481·18 grains. This was abolished by the Act of 1618, which ordered 'that the standards be kept, two firlots by Linlithgow, the stone weight by Lanark, the ell by Edinburgh, and the pint by Stirling, as of old.'

The Lanark stone was 16 lb. of Scots Trois weight. An inscription on the standard still extant states that it was equal to 15 lb. 14 oz. English Troy, that is to the fictive long Troy pound of 7680 grains. The Scots pound, = 7609 grains, was divided into 16 ounces = 475·5 grains, divided into 16 drops.

The stone was blunderingly described (1618) as 'the French Trois Stone containing sixteen Trois ounces.' But it had nothing to do with French weight (in which the ounce = 472·12 grains); its standard was of the Dutch Troy (Trooisch) class, coinciding very closely with that of the Amsterdam pound = 7925 grains, the ounce = 476·5 grains.

When the 7600-grains lb. came to England as the standard of the Assize of Bread, it was known as the Scots or Dutch pound.

An Act of James I (1410), 'That a Stone be made for weighing fifteen Trois pounds and divided into sixteen Scots pounds,' leads to a suspicion that there was another Scots pound, of Rhineland standard; for 16 pounds or double marks of Cologne are very approximately equal to 15 long Troy pounds of English standard.

Troy oz., 480 grs. $\times \frac{15}{16} = 450$ grs. = Tower oz.

One may thus surmise that the royal pound of Scotland, like that of England up to Tudor times, was of Cologne or Tower standard, and was superseded in course of time by the Amsterdam or Scots Trois pound.

Measures of Capacity

In 1410 it was ordered:

That the Boll be divided into 4 Firlots, and contain 29 inches within the boords, and above 27 and an half-inch even over, and in deepness 19 inches; that the Firlot contain in breadth even over 16 inches under and above within the boords, and in deepness 9 inches; that the Firlot contain 2 gallons and a pint, and the Pint to weigh, of the water of Tay 41 ounces or 2 pounds 9 ounces; so the Gallon weighs 20 pounds 8 ounces, the Firlot 41 pounds and the Boll 164 pounds.

This seems as clear as the water of Tay; unfortunately the three firlots mentioned in the first half of the quotation are three different firlots.

There is also a difficulty about the pint. An Act of James VI gives 'the pint of Stirling two pounds and nine ounces Trois, of clear water,' the same weight

as above. But another and previous Act of the same king (1618) orders 'that the Pint weigh three pounds seven ounces Trois of the running water of the Water of Leith'; and this pint is also called the Stirling Pint, Jug or Stoup, so there were two pints, as well as several firlots.

Of the two pints, the standard of one is still extant, which we will call the Stirling Jug or larger pint. It contains 104·2 cubic inches = 60·1 ounces of water, almost exactly 3 Imperial pints, and was 55 ounces or 3 lb. 7 oz. Scots of water. It was not an aliquot part of any of the firlots, but was itself a standard basis of measure, of which the firlot might be 18, 19, 21¼, &c. There is little doubt that it was one of the 'Kanne' of North Germany (Du. *stoop*); these kanne vary at the present day between 2·83 pints in Bremen and 3·2 pints in Hamburg. There was in Prussia until quite recently the Metze of 6 pints or 120·8 ounces, almost exactly twice the larger Stirling Jug.

The other pint, of 41 Scots ounces = 44½ English ounces or 2¼ pints, was not a standard measure. It was merely a divisional unit, one-sixteenth of the above-described wine firlot containing 41 lb. Scots, or 44½ English pounds, of water. This firlot was divided into 2 gallons = 20½ lb. Scots, or 22¼ English pounds; and the gallon into 8 pints of 41 ounces Scots.

What was the origin of this firlot, or rather of the Boll, of which it was a fourth? There is only one measure with which it has any affinity: the half-

Cargo of Marseilles,[1] divided like it, sexdecimally. The two series run thus:

SCOTLAND	Imp. Gall.	MARSEILLES (original Standard)	Imp. Gall.
Boll 164 lb. Scots	= 17·8	Half-Cargo	= 17·76
Firlot 41 ,,	= 4·45	Panau, Eimino	= 4·43
Gallon 20½ ,,	= 2·22	Half-Eimino	= 2·21
Pint, Jug 41 oz.	= 2·2	Pechié (Pitcher)	= 2·21

In the next reign, that of James II, about 1450, another Firlot appeared. It was to be 'a general Mett, according to the Pint and Quart formerly given to the Burgh of Stirling for an universal standard, whereof each Firlot to contain eighteen Pints . . . and that none use another measure.'

Which of the Stirling pints was the Standard? The smaller pint of 41 Scots ounces of water, or the Jug, the larger pint, of 55 ounces?

In this case it was certainly the larger pint; for 18 pints of this standard are very nearly equal to a firlot containing a Rhineland cubic foot of water, 1000 Troy ounces = 1886 cubic inches. Except the slight difference between Amsterdam and Scots Troy weight, this firlot was 62½ lb. Scots, just as the English cubic foot was 62½ lb. averdepois. It was 18 pints of 104·2 cubic inches = 1875·6 cubic inches = 54 Imperial pints or 6·76 Imperial gallons. This corresponds very

[1] There was considerable intercourse between Marseilles and Scotland. The Scots custom of eating grey peas with oil on Carlin' Sunday is taken from the Provençal custom of eating chick-peas on Palm Sunday; and the traditional reason, the arrival on that day, in famine-time, of a ship laden with pulse, is the same at Leith as at Marseilles.

closely to the Himt or cubic Rhineland-foot measure of North Germany, actually = 6·85 gallons.

This was a corn-firlot, and I recognise in it the firlot mixed up with the wine-firlot and only rescued by its stated dimensions corresponding to a capacity so different from the calculated contents of the latter. The dimensions given correspond to a capacity of 1809 cubic inches, a considerable divergence, but the old custom of ordering the gauge of bushel-measures in inches either whole or with simple fractions often caused considerable divergence from the calculated standard of capacity.

Progress through the Acts of the Parliaments of Scotland reveals to us more firlots, with the same anxiety which has been seen in English statutes for unity of standards, with the same attempts to conceal their plurality beneath plausible wording. Under James VI (and I of England) the Parliaments were anxious 'that the measure and firlot of Linlithgow should be the only firlot for all his Majesty's liedges.' It was therefore ordered that the Pint of Stirling be 2 lb. 9 oz. Trois of clear water, and the Firlot of Linlithgow 19 pints.

It has been seen that the Act of James I which ordered the wine-firlot to be 41 lb. in 2 gallons of 20 lb. 8 oz. also stated that it was to contain 2 gallons and a pint; thus making it in one line 16 pints (of 41 ounces), in another 17 pints. The Act of James II ordered the firlot (presumably a corn-firlot) to be 18 pints, of 55 ounces. And then the Act of James VI made the firlot 19 pints, of 41 ounces = $48\frac{3}{4}$ lb. Scots or

53 English pounds. This capacity corresponds approximately to the Schepel of Oldenburg, now = 50 lb.

Yet another Act of James VI (1616) finds the Linlithgow standard of the Firlot to be true and to contain 'twentie ane pincts and ane mutchkin of just Sterline Jug and measure,' but, in order to put an end to heaped measure, it orders a new firlot for malt, barley and oats, containing 31 pints Stirling Jug, and that the pint weigh 3 lb. 7 oz. Trois of the running water of the Water of Leith. Thus different Acts order firlots of 16, 17, 18, 19, 21¼, 31, pints; sometimes the pint is to be 41 ounces Scots, sometimes 55 ounces, and sometimes it is not mentioned which.

The firlot of 21¼ pints was probably an imported measure found to contain that number of pints; 21¼ × 104·2 gives 2214 cubic inches, = 7·98 Imperial gallons, for its capacity, a measure coinciding very closely with the Anker, which varies between 7·83 gallons in Oldenburg and 8 gallons in Lubeck (and 7·95 gallons in the Cape Colony). The Boll of 4 firlots = 4 bushels was equal to the Lubeck Ohm; and the term Anker was used in Scotland for the potato-firlot.

This firlot of 21¼ pints became the Edinburgh firlot; and it happens to coincide almost exactly with the Imperial bushel. It being fixed at 21¼ Stirling pints (of 104·2 c.i.) when 20½ pints would have made it 2136 c.i., almost exactly the old English bushel (2150 c.i.), shows that it was not influenced by the

latter ; it was clearly an independent measure imported by trade. Its series was quaternary :

Boll (of 4 firlots)	= 4	Imperial	bushels.
Firlot	= 1	,,	,,
Peck	= 2	,,	gallons.
Lippy (or forpit)	= 4	,,	pints.

The lippy, as its sixteenth, came to mean a sixteenth generally. The word is a diminutive of the O.E. 'leap,' a basket, e.g. 'seed-lip.'

The barley and oats firlot of 31 pints = 3230 cubic inches is the real Linlithgow firlot. It was the Edinburgh firlot increased to contain the same weight of malt, bear (barley) and oats as that contained of wheat.[1] Its capacity was 11·6 gallons, and its Boll contained 46½ gallons or 5·8 bushels. It was probably a Boll of about this capacity the dimensions of which, giving a capacity of about 43 gallons, were roughly stated in the Act of 1410 as those of the wine-boll.

The Chalder (of Culross) was 16 Edinburgh bolls.

I need scarcely do more than mention the smaller measures: to the Choppin (Fr. *chopine*), half a wine-pint ; to the Mutchkin (Du. *maatje*), its quarter ; to the Gill, its eighth, usually.

The measures of Scotland may be thus summarised : They appear to have all come from North Germany, except one from Provence.

[1] It was a common custom formerly to measure corn by the shallow bushel, striked for wheat, heaped for lighter corn. The oats firlot of 31 pints was ordered to end the practice of giving 'three straiked for two heaped measures [which] do exceed and are not just.'

The Ell was a length of 3 Rhineland feet, divided into 37 inches, approximately of English standard.

The Acre was a North German acker of 160 rods, each 6 Rhineland feet square.

The Pound was the Amsterdam standard of Troy = 7609 grains, multiplied and divided sexdecimally.

The old wine-boll = 17·8 gallons was the half-Cargo of Marseilles, divided into 16 pints of 41 Scots ounces.

The larger Stirling Jug was a North German 'kanne' of 104·2 cubic inches = 55 Scots ounces or 3 Imperial pints. It was the standard of corn-measure; the corn-firlots were multiples of it.

The common corn-firlot was a Rhineland cubic foot = 1000 Troy ounces or 18 Stirling Jugs. It was the North German Himt.

Another firlot was 19 lesser pints = 48¾ lb. Scots.

The Edinburgh Firlot of 21¼ Stirling Jugs or 2214 cubic inches was the North German Anker, become a corn-measure.

The Firlot of 31 Stirling Jugs was a wheat-firlot enlarged to hold about the same weight of oats.

2. IRELAND

There are in Ireland many primitive Celtic measures worthy of study, if merely as showing the ways of thought of the people; but apart from these, the system of weights and measures, established for many centuries, has been the English system introduced in early Plantagenet times.

Some of these measures, relics of that time, long overlaid in England, are of interest; for instance, the gallon of 217 c.i. is one-eighth of the early wine-bushel = 1 cubic foot.

The Irish road and field measures, multiples of the seven-yard rod, have been noticed.

3. Wales

The general unit is the Cibyn (kibbin) = 4 gallons or 32 lb. of wheat, the English half-bushel or tuffet. It is divided into 4 quarts, and 16 cibyns make a Peg = 8 bushels or 1 quarter.

Measures on the English stone system are also used:

The Ffiol	=	1 stone, 14 lb.		
,, Peck	=	3	,,	
,, Hobbet	=	12	,,	about $2\frac{1}{2}$ bushels.

There is a Hobbet in England, but this is about a bushel.

The 5-span Ell survived in Wales for a long time as the Hirlath.

CHAPTER XII

MEASURES AND WEIGHTS OF SOME BRITISH DOMINIONS

1. The Channel Islands

These measures are the connecting links between those of old France, through Normandy, and those of England, especially in land-measures. Normandy had a system of measures kept in fair unity by the English dukes of Normandy.

'Thanks to their firm administration the English system was generally marked by a scientific regularity which, notwithstanding its complication, is in remarkable contrast with the barbarous French system.' [1]

For England had already, at the Norman Conquest, a good system in which weight, wine-measure, corn-measure, and linear measure were co-related; albeit this co-relation, under the influence of the royal mint pound, was forgotten for many centuries, and is indeed scarcely known at present.

But Northern France and Normandy had no such

[1] *Etudes sur la condition de la classe agricole en Normandie au moyen age* (Leopold V. Delisle, 1851).

co-related system. Southern France had an excellent system, indeed that of Marseilles was perfect; while Paris, taking its measures from the South, destroyed their co-ordination and was careless of their standards.

None of the Paris series had any simple relation. So it was in Normandy, where the systems of North and South were mixed with Teutonic measures.

The original Norman perch, like that of England,

et est la mesure 16 *pies la perque,*

probably Rhineland feet, but perches of 20, 22 and 24 Paris feet, often of reduced Paris feet, superseded it. The Acre was always 4 Vergées or roods, nearly always of 40 square perches, and divided into quarters.

The charuée, caruée or ploughland was usually 60 Normandy acres, divided into 12 bouvées or ox-gangs, each of 5 acres or 20 vergées.

Corn-measure had for principal unit the Bushel, 8 of which made a Quarter, a quarter of a horse-load or, if large, of a cartload. The bushel was, or appeared usually to be, a multiple of the Pot; this led to divergencies according to the number of pots taken; yet it seems probable that the Pot was itself a fraction, an eighth, a tenth, a twelfth, or a sixteenth of some bushel either wine-measure or corn-measure.

While the weights and measures of Paris had established themselves in Rouen and Caen, local measures more in agreement with Norman customs were in general use. Thus the Paris bushel = 793 cubic inches was scarcely used. A typical Norman measure was the *Boisseau étalon de l'abbaye de Jumièges,* con-

taining, as nearly as I could measure, 1648 cubic inches. Now this is very approximately a cubic foot of the reduced Paris 11-inch standard usual in Normandy, akin to the 11-inch foot of Jersey. This cubic foot was very nearly the Roman cubic foot or Quadrantal; for the reduced Paris foot, = 11·72 English inches, was very nearly the same as the quarter of the aune, which was 4 Roman feet very approximately.

There was another standard Bushel—the *Boisseau étalon de la Ville de Bolbec*—containing, as nearly as I could measure, 2534 cubic inches.

There is also a peculiar measure for apples, the *barattée* or churnful, usually of 25 pots.

In Normandy as in the rest of France weights were not related to measures. It was always known what was the usual weight of corn in the bushel; thus the Paris bushel was supposed to hold 20 French pounds of wheat.

Some heavy pounds, brought possibly by the Normans, disappeared gradually before the Paris Troy pound. Wool-weight brought from England was used; the sack being 36 stone of 9 French pounds or about 350 averdepois pounds.

Such was the system of measures and weights used in Normandy, and surviving there in great part. The slightly differing systems of the Channel Islands are simply variants of this system, a rough sketch of which I have given by way of introduction to them.

Jersey and Guernsey (the latter including Alderney and Sark in its government) are each practically autonomous. The Islanders keep their Norman laws,

customs and dialects, and retain their systems of measures, weights and currency. These are being gradually modified by increased intercourse with England; and French influence tries hard, especially in Jersey, to introduce the metric system.

Linear and Land Measures

1. *Jersey.*—For ordinary linear measures the English standards are used, the yard and the pied du roi; that is the English foot. There is also an ancient ell of 4 feet.

For land measure the Jersey foot is 11 English inches (but divided into 12 land-inches); and 24 of these feet make a perch = 22 English feet. This peculiar standard is evidently an adaptation of the Norman custom (which prevailed in France) of making 24 short feet of either a quarter aune, or 11 pouces, the perch or verge, which became officially the *perche d'ordonnance* of 22 French feet.

The Jersey Vergée or rood is 40 square perches = 0·44 acre.

2. *Guernsey.*—The linear measures are based on the English standards. They were, in 1611:

Cloth yard	= 38½ inches (= half a toise).
Sail Cloth yard	= 44 ,,
English ell	= 45½ ,,
English yard	= 36 (Verge d'Angleterre).

The perch or verge is 21 feet; probably an approximate adaptation of the common perch of 20 French feet = 21·3 English feet. It is the same as the Irish and Lancashire rod.

The verge or rood is 40 square perches = 0·4 acre.

The acre-unit is not used now in either island.

The bouvée (bovate) of 20 vergées, and caruée (carucate) of 12 bouvées remain only in manorial records.

Measures of Capacity

1. *Jersey.*—The standard ordered in 1754, and confirmed in 1771, is the Cabot, defined as containing 10 Pots.

The Pot contains 123·56 cubic inches = 0·445 Imperial gallon. It does not correspond directly to the Paris pot = 111 cubic inches or 0·41 gallon, nor apparently to the various Normandy pots, of which that of Caen, about Paris standard, is the type. It is simply one-tenth of the Cabot.

The Cabot, a common name in Normandy for a corn-measure, is for wheat and for wine, cider, &c. A larger cabot, for barley and other light grain, is one-third larger, containing 13⅓ pots; another, for coal, contains 14 pots. Lime and charcoal are measured by the cask of 120 Pots, i.e. 6 bushels of 20 pots. For a double cabot is usually called a bushel.

The Cabot = 1235·6 cubic inches, and containing 4·456 gallons, coincides nearly with one-eighth of the Paris Setier = 4·29 bushels, and also with the Panau or Eimino, ⅛ of the Marseilles Cargo of 4·34 bushels.

It is divided into 6 Sixtonniers.

For wine, cider, &c., it is divided into gallons (double pots, ⅙ cabot), pots, quarts and pints.

A double cabot is the bushel. The duodecimal

division of the Paris Setier and the division (in the corresponding wheat-water series) of the Quartant into 9 veltes, prevent the relations of the Jersey measures with those of Paris being clearly seen. But the relations with the Marseilles standards, corn and wine, from which the Paris standards were taken, are evident. It will be seen in the chapter on the Old Measures of France that the Paris Setier was derived, through the Marseilles Cargo, from the Egyptian Rebekeh, which is the cubed cubit of Al-Mamūn.

The Cabot has been stated (Ansted, 'Channel Islands,' 1862) to contain 43 lb. 7 oz. of water. On this estimate = 4·344 gallons, it is exactly the Marseilles Eimino.

Marseilles		Jersey	
	Gallons		Gallons
Cargo	34·72	Quarter (8 Cabots)	35·6
Sestié	8·68	Bushel	8·91
Eimino, Panau	4·34	Cabot	4·45
$\frac{1}{6}$,,	0·72	Sixtonnier	0·74

Fluid Measures.

Escandau	3·54		
Quartié	0·885	Gallon	0·89
$\frac{1}{2}$,,	0·442	Pot ($\frac{1}{10}$ Cabot)	0·445
Pot, Pechié	0·221	Quarte	0·222
Fuieto	0·11	Pinte	0·111

N.B.—The Escandau is the Panau diminished in wheat-water ratio. The Jersey pot is the fluid measure in wheat-water ratio with $\frac{1}{8}$ cabot.

There seems no doubt that the cabot is the eighth

of the setier (and of the Cargo), slightly variant, as the Jersey pound is a variant of the Paris pound.

There is also a measure for apples = 3·77 bushels or 30 gallons. The ordinary barattée (churnful) of apples in Normandy is 25 pots = 10 gallons.

The larger Cabot for barley and other grains except wheat was to be = $1\frac{1}{3}$ of the wheat cabot, that is $13\frac{1}{3}$ pots; it was therefore = 5·933 gallons, very nearly $\frac{3}{4}$ an imperial bushel = 1647 c.i. Was it fixed at this size to hold approximately the same weight of barley, &c., as the smaller cabot held of wheat, or was it the Boisseau de Jumièges = 1648 c.i. approximately? That I cannot say. But the question is of some importance historically, for Guernsey adopted a bushel of about this capacity, the lineage of which is a matter of considerable interest.

2. *Guernsey*.—In 1582, also in 1611, the Guernsey bushel was ordered to be 16 inches diameter and 8 inches deep; it was to hold 13 pots and a quart. The pot was not defined: at the end of the seventeenth century it is recorded to be equal to 121 cubic inches. On this basis the bushel should be 1633 cubic inches, but according to the dimensions ordered it contains only 1608 cubic inches. This is evidently one of the cases where the wish to order a measure of simple dimensions has caused the standard to deviate practically from its calculated value. There is considerable doubt as to the capacity of the pot, the original standard of which is not extant. But from the definition of the Guernsey bushel as $13\frac{1}{2}$ pots of approximately 121 cubic inches, it would seem that this was considered as

M 2

roughly equivalent to the 13⅓ pots, each 123½ cubic inches, of the Jersey barley-bushel = 1647 c.i.

The bushel is divided, on its calculated capacity of 13½ pots, = 1631 c.i., into

2 Cabotels		
6 Denerels (Jersey sixtonniers)	= 272	c.i.
30 Quintes	= 54½	„

The Denerel is thus, probably by mere coincidence, exactly the old corn-gallon, and the bushel is 6 corn-gallons.

The word Denerel means ‘standard’ in the sense of the standard coin or pattern piece, the Denerial or Deneral, to which the French moneyers had to strike deniers or silver pence. We may confer with this term the Marseilles Escandau, meaning ‘standard,’ a measure = 3·54 gallons, the basis of a whole system of measures.

But if the bushel were based on another measure than the obsolete pot—on a standard still extant in the Sheriff's Office, the

Quinte, grande mesure du marché de Guernesey 1615,

it would be of larger capacity. For the Quinte, I found when I measured it in 1885, is approximately 54·7 cubic inches, and it is stated to contain fully 32 ounces of water. As it happens to be equal to a fifth of the imperial gallon, the Denerel should be equal to an imperial gallon, and the bushel to 6 gallons.

There are two other bushels:

The Coal-bushel (1611) of 18½ inches diameter, by 8 deep, then stated to be equal to 16¾ pots (an evident

mistake, in Roman numerals, for 17¾ pots) and containing an English corn-bushel.

The Barley-bushel, 1625 and 1673, to contain 17½ pots ; of such size that it should hold, striked, as much as the wheat-bushel held when heaped. Its calculated capacity is 2117·5 c.i. = 7·63 gallons.

Wine-Measures

These have assimilated themselves in the course of trade to those of the countries of exportation, but the fluid measures of the islands still subsist for cider and other liquors. The Jersey gallon is, or was, 2 pots = 247 c.i. The Guernsey gallon is, or was, ⅛ of the bushel = 252 c.i. or perhaps 2 pots = 242 c.i.

Both are somewhat over the old English wine-gallon.

Weights

The Jersey pound, = 7561 grains, is 7 grains over the old French pound ; 104 pounds make a cwt. = 112·3 lb.

The Guernsey pound, = 7623 grains, differs by only 2 grains from the Amsterdam pound ; 100 Guernsey pounds = 108·9 lb.

There is a tradition that this pound was originally 18 ounces of Rouen weight, reduced in 1730 to 16 ounces. But it is not 16 ounces of any weight but that of Amsterdam. It may have been originally 16 ounces of some heavy pound with an ounce of about 530 grains, akin to the Austrian and Russian ounce ; then converted into 18 lighter ounces, and

afterwards 16 ounces were taken for the pound. In the seventeenth century it is recorded as being 18 ounces of 471 grains, which is approximately the Paris standard = 472·1 grains. In 1730 it was ordered to be of 16 ounces, but of what standard there is no evidence. And in the nineteenth century it is 16 ounces of 476·6 grains, almost exactly the Amsterdam standard. It looks as if the change in 1730 was to 16 ounces of another standard, Amsterdam Troy, instead of French Troy.

I have given some space to these Channel Island measures, so interesting as a survival of Norman measures and as a link between the measures of old France and of England. The peculiar monetary system of Guernsey will be given in Chapter XIII.

2. South Africa (Cape Colony)

Here we find two systems, those of Holland and of England, used according to public convenience, and combined as far as possible. The linear standard is Rhineland; the foot = 12·356 inches. The rod is 12 Rhineland feet; the English mile is reckoned as 426 rods.

The land-unit is the Morgen = 2·12 acres, of 600 square rods.

Weights are now Imperial; with a cental-cwt., and a ton of 20 centals or 2000 lb.

For corn measures, Imperial and Dutch measures are combined in the Mud of 3 bushels or 4 Schepels.

For fluid measure the unit is the Anker = 7·95

gallons, a lower standard than the Amsterdam anker = 8·5 gallons, probably through the influence of English measure. The Legger (leaguer) is 126·6 gallons, in 4 Aam, 16 Anker and 80 Velts. This gives the Velt somewhat a lower standard than in Java, where the legger = 127·34 gallons, and the velt = 1·59 gallons.

3. India

Of the measures and weights of India, a country containing one-fifth of the population of the world, divided into many nationalities, only a slight sketch can be given, and that chiefly of the measures used in British India as distinguished from the tributary states. The measures of the Aryan population of Hindustan, and those of the Dravidian peoples of peninsular India, are different; moreover the influence of the Moslem conquerors, Moghul and Pathan, of the Portuguese in the sixteenth and seventeenth centuries, of the English in more modern times, has modified these measures.

As in other Eastern countries the linear unit is usually a cubit, the *hástha* or *háth*, divided into 24 digits. Traces of the Egyptian increased cubit are to be found. In a classical work on architecture, the Mánasára, the Hástha, of 24 digits for timber, is increased to 25 for temples, to 26 for houses, to 27 for municipal buildings and land. The addition of 3 digits to the 24 of the Egyptian common cubit would give 27 digits, approximately equal to the 28 smaller digits of the royal cubit.

In Southern India the cubit is sometimes the *mūyangál* (*mūyam*, cubit; *kál*, leg), the length from the knee to the ankle.

In Malabar the unit is the Kol = 28¼ inches as used for timber; but for land it seems to have increased to 30 inches.

The kol was probably 3 spans or half-cubits of 9·41 inches.

A guz brought by the Moslems, = 33 inches, has established itself in Bengal. It was probably 3 Belâdi feet of 10·944 inches.

The Portuguese Covado of 3 spans = 27·17 inches, usually taken as 27 inches, has established itself in Western India. It is divided into 48 digits, of which two-thirds, i.e. 32 digits = 18 inches, are the usual cubit; ⅛ of this = the English nail.

All these measures appear to have been modified by the English foot and inch.

Native itinerary measures are rough and variable; the Koss of 100 fathoms is the usual standard.

Land-measures are of course very variable.

12 guz, usually = 33 feet, make a cord or chain, and 5 cords make a Jarib = 10 rods. A square jarib = 100 square rods, is the usual Bigha of Northern India = 0·625 acre.

Another unit is the Mah of 100 rods 12 × 12 feet = 1600 square yards, about half the above bigha.

Land-units, like most other units, can be divided into 16 annas, so that the anna of the bigha is 200, that of the Mah is 100, square yards.

In Madras the unit of land measure is the Káni

(cawny) = $1\frac{1}{3}$ acre of 24 grounds = 6400 square yards. So there appears to be a common unit of about 1600 square yards, with its anna or sixteenth = 100 square yards or 10 yards square.

Five káni make a Véli, the usual extent of arable land which can be cultivated for rice or other wet crops by a peasant with a yoke of oxen.

Everywhere there are seed-measures of land, as in other countries.

Weights

These are derived from a coin-weight basis, the silver rupee-weight or Tola in most parts, the golden pagoda-weight or Varahan in the south of India. In each case 80 of these coin-units made a Sér. (See Indian Coinage, in Chap. XIII.)

The Bengal sér, 80 tolas of 180 grs. = 14,400 grs.

The Madras sér, 80 varahan of 54 ,, = 4320 ,,

The Bombay sér was based on another gold coin, the *tanc* (gold) of a little over 68 grains, 72 of which = 4900 grains.

The Bengal sér is, curiously enough, = 2 Cologne pounds of 7200 grains. It is divided into 16 chittaks or double ounces of 5 tolas. The tola is divided into 12 mashas (= 15 grains) of 8 ráti (the red seed of *Abrus precatoria*) : 40 sér make a mánd = 82·28 lb.

This sér (Ang. seer), the Government standard, is really a Troy weight. The rupee of different standard in the three presidencies was fixed in 1833 at 180 grains, 3 drachms of the Troy ounce ; this being so, the sér of 80 rupees weight is = 30 Troy ounces and

the mánd of 40 sérs is = 1200 Troy ounces or 100 Troy pounds.

About 1870–72 the metric propaganda was epidemic among Indian Government Engineers; light railways were made on metre-gauge, and a nearly successful attempt was made to get the sér fixed at one kilogramme. An Act was about to be passed to this effect when the death of Lord Mayo stopped it, and the Act fell through.

The Bengal sér and mánd[1] are the usual weights for official purposes. Some other sérs are used, often of low standard known as Kucha sérs (unripe, half-baked) in regard to the pukka (ripe, full-measure) sér of 80 tolas.

The Madras mánd was = 24·68 lb.; 20 mánd = 1 kándi, 493·7 lb.; but English trade considered the mánd as 25 lb. and the 'candy' as 500 lb.

Madras had also a weight called the Vísham (Ang. Viss) of 120 tolas = 5 of its sérs, or 3·086 lb. divided into 40 pollams.

Capacity

To this Madras weight corresponds the Adangáli, dangáli or puddi, or measure containing a vísham of grain, and therefore a pound-pint measure = about 3 pints. It is the usual measure of the daily grain-wage of agricultural labourers.

[1] The difficulty in representing the sound *á*, *ah*, in English letters led to a general substitution of *aw*. Hence 'cawny, maund, ghaut (steep), pawni (water), cawn (khan),' &c.; all these words having an *a*, or *ah*, vowel. The Anglo-Indian also says *seer* for sér.

Similarly in other parts of India, the sér measure contains a sér weight of the usual food grain.

The measure is usually heaped, and whether sér or dangáli it delivers approximately either a sér or a vísham of the usual grains, rice, wheat, millet, pulse, &c. It is a pound-pint measure, avoiding the use of the balance. The Madras Government wanted to fix the dangáli at 100 cubic inches, but this would have been useless as not delivering a vísham. The necessary capacity to deliver a vísham of water is found by 3·086 lb. × 27·725 to be 85·76 cubic inches. Increased in the Southern water-wheat ratio of 1 : 1·22, we have 104·62 cubic inches as the true dangáli measure. So Government allowed 104¼ cubic inches, and this was about the capacity of a dangáli 8 inches high by 4 inches diameter, often a section of bamboo cut down to the proper capacity.

In Madras, the dangáli, puddi or measure is then = 104¼ c.i. divided into 8 ollocks; and 8 dangáli = 1 Mercál; 424 mercáls, = 120 Bengal mánds, made a Garce, which is a Government measure for salt = 4·4 tons.

The cubic measure used in Southern India for dry goods, such as lime, is the Parah = 5 mercáls = 5 × 8 dangáli, or 4000 cubic inches at 100 c.i. to the dangáli: but 4184 c.i. at the customary capacity of that measure; so the parah is = 15 gallons.

The Bombay parah = 4½ gallons.

The Ceylon parah = 5·6 gallons; 8 parah = 1 amómam = 5·6 bushels.

To the amómam of grain corresponds the amómam

of land, which, at 2 bushels seed to the acre, = 2·8 acres. By measurement it is 2·74 acres.

4. Burma and the Straits

In Burma, as in the ancient Eastern Kingdoms, there was a common cubit and a royal cubit. The former, = 19½ inches, was of 24 digits, in 3 taim or handshafts; the latter = 22 inches. Here we have repeated the two Hindu *hástha* of 24 and 27 digits; the royal cubit being almost exactly $\frac{27}{24}$ of the common cubit.

The basis of weight is the Tikal (shekel), = 252 grains (= 1 cubic inch of water), divided into 4 moo, = 63 grains, and 16 gyi of 15¾ grains (corresponding to the Indian masha), of 8 rati.

100 tikal = 1 piet-tha = 3·6 lb., corresponding to the Indian vísham.

The principal measure of capacity is the teng or basket, somewhat less than a bushel; it contains 16 piet of rice = 57·6 pound-pints.

The tikal of Siam = 234 grains; 80 tikal = 1 catty = 2⅔ lb.; 50 catty = 1 pikal, = 133¾ lb., or about 2 bushels of rice.

The Pikal (i.e. man's load) of Singapore (and of China) = 133⅓ lb., is of 100 catty; the catty = 1⅓ lb. of 16 taels = 1⅓ oz. The tael is of 10 mace; the mace is a Chinese coin-weight = 58⅓ grain, the representative of the Greek and Asiatic drachma in the Far East.

The pikal of Java = 135·63 lb., similarly divided.

The hyak-kin or pikal of Japan = 132½ lb. It is also of 100 catty or kin = 1·325 lb. of 16 × 10 momme,

the latter a weight equivalent to the mace = 58 grains; and 10 × 10 momme make another unit, the hyaku-me = 5797 grains.

I refrain from doing more than giving a glance at the weights and measures of the Far East; suffice it to say that most of them have every appearance of being Arabic in origin.

5. Canada and Mauritius

Canada

The Imperial system is used, but the Cental replaces the long Cwt. and its stone divisions.

In the old French districts of Quebec certain old French measures are lawful: the Paris foot, the perch, usually of 20 feet, the Arpent of 100 perches.

The Minot, of 3 boisseaux = 1·073 bushel, is still used.

Mauritius

This island, formerly a French colony, retained the old French measures and weights: the Paris foot, the Toise, the Mille of 1000 toises = 1·21 mile, the Perch, usually of 18 feet, the Arpent of 100 perches, the French livre, the corn-setier, the wine-setier or Velte = 1·639 gallon.

The Metric system was substituted in 1876, notwithstanding that 'the feeling of a great portion of the community was so strongly against it that in 1882 it was thought to be not improbable that the British Imperial weights and measures might be reverted to' ('Merchants' Handbook,' by W. A. Browne, 1899). It is added that this antagonistic feeling gradually died out, but evidence on this point would be desirable.

CHAPTER XIII

MEASURES OF VALUE

1. English Money

In all times money has been the weight of a certain amount of copper, silver or gold, in the form of coins the fineness of which is guaranteed by the stamp of the State. The weight of coins used in payments may change in course of time, but the nominal unit of weights often continues, the pound, or livre, or marc, &c. Thus, the original Roman unit, the As, or mint-pound of copper or bronze, reduced gradually to $\frac{1}{24}$ of its primitive weight, persisted as a money of account long after it had been replaced in the currency by the silver Denarius. This was originally coined at a time when it represented the value of 10 As; hence its name deni-aris, ten of copper.

The French livre, or livre d'estelins, reduced gradually to a coin about $\frac{1}{74}$ of a 12-oz. livre, retains its name as a synonym of the franc.

The English pound of silver, once a Tower pound = 5400 grains, reduced long ago to 1745 grains, in 20 shillings, persists as a money of account, though the silver is superseded in payments over 40 shillings by

a gold coin weighing $123\frac{1}{4}$ grains. Prices over 40*s*. are still often stated in shillings.

The Roman denarius originally weighed 60 grains, afterwards reduced to $52\frac{1}{2}$ grains. A golden denarius was also coined, which afterwards became the Arabic dinar.

Under Charlemagne the mint weight of France was heavier than the marc of Troyes afterwards adopted as a standard. Adapting the Roman system to the customs of his Teutonic subjects the emperor Karl divided the pound of silver into 20 silver solidi or sols, each equal to 12 silver penings or pennies of about 25 grains which, assimilated to the Roman denarii, were called deniers, also estelins or sterlings. The solidus appears to have corresponded to a Teutonic monetary unit, the shilling, equal to a variable number of penings, which coins were not of uniform value until about Charlemagne's time.

The Carlovingian systems of coinage had passed to England long before the Norman Conquest, displacing the old Norse and Saxon systems—the Norse, in which the Ore was of 20 silver penings = $\frac{1}{8}$ marc or $\frac{1}{12}$ lb., and the Saxon Sceatta of 40 Styca, usually equivalent to pence. The shilling, = $\frac{1}{20}$ pound of silver pence, became established—'xxx scyllinge penega,' thirty shillings of pence ('Saxon Chronicle,' 775). The Norman Conquest made no appreciable change in the English customary coinage. The Tower pound of silver which the Normans found established was coined into 240 of the 'English peny called a sterling,' each weighing $22\frac{1}{2}$ grains instead of the 25 grains of

Charlemagne's sterlings. Twelve pence made a shilling of 20 to the pound, and twenty pence or pennyweights made an ounce of 12 to the mint-pound.

England soon followed France, but much more slowly, in the usual dwindling of the weight of coins, as the king, pushed for money, ordered his moneyers to melt down the silver pennies and recoin them of lower weight. They remained at 22½ grains down to the time of Edward I. Edward III's first pennies were of 22¼ grains, but in the 18th year of his reign they weighed 20¼ grains, in the 20th year 20 grains, and after the 27th year he made the pound of silver yield 300 pennies at 18 grains. He also coined groats (great sterlings or grosses). Silver halfpence (mayles) and farthings (ferlynges) were coined, and a statute specially ordered that no sterling halfpenny nor farthing be molten 'for to make vessel or any other thing by goldsmiths nor others.'

At this time, if we may believe the Statute of Labourers, one penny was the usual daily pay of the farm-labourer, but mowers were to have fivepence by the acre or the day. Prices of farm-produce were fixed. A penny would buy a chicken or six pounds of bread, 2 pence a fowl, 4 pence a goose.

The diminution in the weight of the penny was slow and did not affect wholesale dealings in which payment was usually made by weight.[1]

[1] Clipping the pennies, against which crime frequent statutes threatened punishment, affected the poor who paid and were paid by tale, not by weight. It afforded a pretext for occasionally raiding the Jews and plundering their store of coin, always found of course to have been clipped.

In all but retail transactions payment might be agreed to be by weight. In Stephen's reign the land-revenue of countries was farmed out. The sheriff or 'fermour' of Wiltshire and Dorsetshire paid into the treasury £454 10*s.* by weight (ad pensum) and £262 4*s.* by tale (numero). He probably picked out the full-weight coins for payment by tale, and had to take (as perhaps he received) weight-value for the rest.

Under Henry IV the sterling had fallen to 15 grains; under Edward IV it fell to 12 grains, at which weight it stood till Henry VIII brought it down to 10½ grains, and also debased it to only one-third its weight of silver. His father had coined shillings, hitherto only a money of account; his own mint continued this coinage, but got 48 of them, instead of 20, from the Troy pound of silver, and subsequently by debasement nearly 150.

In Edward VI's reign the Protector Somerset continued this system, but, at his fall, efforts were made by the Council to restore honesty to the coinage, at least as regards the shillings and crowns. The pennies remained debased until the wisdom of Elizabeth restored the standard, and since that time our silver coinage has remained of true standard and at the weight of 7½ grains for each penny value, or one-third of its weight at the time of the Norman Conquest. The Scots silver coinage fell much lower than that of England; by the time of the Union it had fallen to $\frac{1}{36}$, the pound Scots being worth 20 pence English, instead of 20 shillings.

It is curious that the kings, so ready to make a profit by lowering the silver coins, appear to have

disdained the evident profit of a copper coinage. Penalties were repeatedly threatened by statute against the copper coins which necessity of 'change' caused to be made or imported. These were unlawful coins called galyhalpens, saskyns, dodekyns and dotkins (probably Scottish 'doits'). James I granted a patent for the making of copper farthings. Halfpennies were first coined in Charles II's time, but it was not till near the end of George III's reign that a copper penny was struck, probably because the tradition of the silver penny weighing 32 wheat-corns, albeit shrunken, was against the penny being other than silver.

The penny was at first a full ounce of copper. Two-penny pieces were also struck weighing two ounces.

The present bronze coinage was made in 1860 after the example of the bronze coinage of Napoleon III, the reformer of the French currency; it was he who established a gold standard in France, hitherto a 'silver country.'

A bronze penny not much worn weighs $\frac{1}{3}$ oz., the halfpenny $\frac{1}{5}$ oz. The latter is one inch in diameter. The silver penny of early Plantagenet times was the size of the present sixpence but thinner, so that, at the full weight of $22\frac{1}{2}$ grains, it was slightly heavier than our threepenny piece = 21·8 grains. It bore the effigy of the king with 'Henricus Rex' or suchlike inscription; on the reverse was a cross, with pellets or other ornaments in the intervals, and the name of the moneyer and city, as 'Edmund on Lin(coln).' The cross gave rise to the idea that it indicated where

the penny could be broken or cut into halfpence or farthings. Doubtless it was so cut where change was scarce; and the first silver farthing was coined by Edward I, 1279, to prevent this cutting up of the pence, but equally with a cross.

At present silver pence and twopences are only coined for Maundy money.

The groat of four pence, grossus sterlingus, first coined about 1279, discontinued from the time of Elizabeth, who first coined sixpences and threepences, was revived in 1836 at the instance, or insistence, of Joseph Hume, an M.P. who, it is said, found it convenient for the exact payment of an 8*d.* London cab fare not exceeding a mile in the days when copper pennies weighing an ounce were inconvenient to carry in the pocket. He died in 1855, and in 1856 the Joey was discontinued.

The threepenny piece was revived in 1845.

The florin was first issued in 1849, an ill-advised attempt at decimalising the pound; it bore the inscription 'one tenth of a pound,' but it has utterly failed to take the place of the convenient half-crown, an important unit in the binary division of the pound. Public convenience appreciates the gold sovereign and half-sovereign, the silver half-crown, shilling, sixpence and threepence. The florin is a disturbing coin offering no advantage over two separate shillings; and the double florin is worse.

No one wants the pound decimalised except a few decimal unpractical persons. A properly taught schoolboy adds up sums of money duodecimally for the pence,

decimally for the shillings, converting these by twenties into pounds. It is quite easy to add up a column of pence thus: 8 and 5, 1*s.* 3*d.*; and 10, 2*s.* 1*d.*; and 8, 2*s.* 9*d.*; and 5, 3*s.* 2*d.* With the shillings column the units are put down and the tens carried to the column of tens; an odd 1 is put down and half the remainder carried to the column of pounds.

English silver coins are $\frac{37}{40} = 0{\cdot}925$ fine, i.e. 11 oz. 2 dwt. of the now obsolete 12 oz. mint-pound.

French five-franc pieces are at 0·900, other silver coins are 0·835 fine.

Gold Coins

Of the two precious metals, only one can be the standard of value. In a gold-standard country, as England has been since 1816, the golden sovereign of lawful weight is the standard of value. As the price of silver, like that of every other commodity, varies with demand and supply, it would be futile to attempt to make silver coins correspond in actual metal value to gold coins; especially as, since the great fall in the price of silver from its demonetisation in many countries and its large production, silver coins are really tokens; tokens of value, but still tokens, not legal tender above a certain amount. A shilling melted down is only worth fivepence or less; while sovereigns melted down can be exchanged, at a trifling charge, for their weight in minted gold.

In silver-standard countries it is gold which varies in price. Thus in India, where for centuries the standard of value has been the silver rupee now weigh-

ing 180 grains and worth fifty years ago a little over two shillings, gold coins of the same weight called 'mohurs' were current at market price, about 16 rupees more or less. Sovereigns were worth about 10 rupees in 1860; they would exchange now for double that price did not the Government of India, by restricting silver coinage and other legitimate devices, keep the gold price of the rupee at about 1*s.* 4*d.*, so that 15 rupees will buy a sovereign for transactions with England and other gold-standard countries.

Gold was coined in ancient Rome. The gold solidus or aureus of Constantine was $\frac{1}{72}$ of an As or mint-pound; so that it weighed 70·14 grains. It was called 'solidus,' entire, as distinguished from the semissis and tremissis, its half and third. The original French sol, or shilling, was an 'entire' of 12 deniers; hence the £ *s.* *d.* we use were once the current signs, in France and elsewhere, for libræ, solidi, denarii.

There were some gold coins of the early Saxon kings. Under the early Norman kings foreign gold coins were current, but the first regular gold coinage was that of Edward III; his Noble of fine gold, $\frac{1}{50}$ of a Tower pound, weighed 108 grains, the weight of two golden florins of Florence or of two ducats or zechins of Venice. He afterwards coined nobles at the rate of 42 to the mint-pound; these weighed 119 grains, and, as they were of $23\frac{7}{8}$ carats fine, contained almost exactly the same weight of pure gold as the modern sovereign of $123\frac{1}{4}$ grains. Their value was about half a marc or 80 sterlings of full weight, and as the proper weight of silver in English coins was then three times

that at present, the 6*s.* 8*d.* equivalence of the noble then is that of the sovereign now.

The weight of gold coins mattered little in practice; they were always weighed, and represented an amount of sterling varying according to the state of the money-market and to the condition of the silver coinage.

Edward IV's noble was called a Rial; and the Angel, $\frac{2}{3}$ of its weight or about 80 grains, was also coined. Henry VII coined a double Rial of half a Troy ounce. Under Henry VIII this was called a Sovereign.

The fineness of gold coins, originally of 23 carats $3\frac{1}{2}$ grains = 994·7 gold in 1000, was reduced to 22 carats under Henry VIII and, after some variations, this standard = 916·6 gold in 1000 was finally adopted.[1]

Sovereigns or Unites were coined under James I at 172 grains, under Charles I at 141 grains. Their value in silver varied of course according to market-rates for gold. Coined under Charles II at 130 grains they were henceforth called Guineas, varying in value from 30 to 20 shillings. Repeated attempts to fix their value by law utterly failed. In the eighteenth century it was generally above the 21*s.* standard at

[1] 'Twenty-four carat' was taken as the standard of pure gold because the Roman gold solidus weighed twenty-four carats (each $\frac{1}{144}$ of an ounce). The assayer's carat is $\frac{1}{24}$ part divided into four assay-grains. Medieval gold coins such as Edward III's noble and the Venetian zechin, always of the same quaint pattern, were generally twenty-three carat $3\frac{1}{2}$ grains fine, = 995 parts in 1000. But this nearly pure gold being very soft, it became customary to alloy the metal with a certain amount of copper to give it the hardness necessary for trade purposes in modern times.

which the guinea is still reckoned as a polite coin. In 1816, on the adoption of a gold standard, the name of Sovereign was revived for the coin which is its basis.

The sovereign weighs 123·274 grains, of which 113·006 are pure gold. It is light if it weighs less than 122½ grains, that is if it has lost more than 1½*d.* in value. Its life of current weight is about 20 years in ordinary circumstances of circulation.

The mint value of gold is £3 17*s.* 10½*d.* an ounce Troy; that is 2·1212 pence a grain pure, or 1·7676 penny at the standard fineness of 22 carats = 916·6 in 1000.

France adopted a gold standard in 1855; other countries followed.

The United States adopted it in 1900.

The sovereign is coined at full value without 'seigniorage.' In France and other gold-standard countries a charge is made for coining. In France this charge is 6 fr. 70 c. on the kilo of standard gold, 0·900 fine, value 3100 francs; this is equal to 0·216 per cent., so that 20-franc pieces lose 4·4 centimes or nearly a halfpenny each on being melted, besides assay charges.

The history of mint-weight will be further told in Chapter XX, section 'The Carat and the Grain.'

2. Guernsey Currency

In this curious relic of the old French monetary system the Livre is the equivalent of the *louis d'or* of 24 francs; the Sol or sou is a shilling, $\frac{1}{20}$ of the livre; the Denier is a penny, $\frac{1}{12}$ of the shilling, and it is

divided into 8 doubles, each equal to the old French *liard* or quarter-sou of 3 deniers, not to the old French double of 2 deniers. The only Guernsey coins are the bronze pieces of 8, 4, 2, 1 doubles; that of 8 doubles being the penny.

The silver coins are French, counted 10 pence to the franc; so that the five-franc piece passes for 4*s*. 2*d*. Guernsey.

The Guernsey pound is either a bank-note for this amount, or 24 francs in French silver, equal to 240 Guernsey pence. Sovereigns are current, taken at the usual rate of 25 francs and 2 pence = 252 pence or 21 shillings Guernsey. So the English sovereign becomes a guinea in French silver and Guernsey bronze.

The people of Guernsey hold by their old system; they find no inconvenience in it; and it is decidedly advantageous to the English resident in the island.

3. Indian Money

The East India Company made little change in the monetary system of the Mogul Empire. In the greater part of India the silver rupee was the standard of value, and the E.I.C. struck Sicca rupees (*sikkah*, coined) in the name of Shah Alam, the Great Mogul reigning at the end of the eighteenth century. These weighed 192 grains, but they were superseded in 1836 by the present standard of rupee, 180 grains, of which 165 fine, bearing the English sovereign's head. The rupee is divided for account into 16 annas, each of 12 copper pies, though the coin so called bore until recently the Persian inscription *salas pai*, one-third of

a pie ; the real pie, inscribed *ek pai*, one pie, being the quarter-anna.

There are silver coins of a half, quarter and eighth of a rupee, but no anna coin. The copper or bronze coins are half, quarter and twelfth annas.

The monetary system of the Madras Presidency (the people of which are a different race, speaking Dravidian languages, not the Indo-European languages of which Hindustani is the *lingua franca*) was different from that of the rest of India. It was a gold-standard country, the monetary unit being the 'Varahan' or 'pagoda,' a small thick gold coin of 53 grains, reckoned as equivalent to 3½ rupees or nearly 8 shillings. There were also gold Fanams of about 6 grains, and still smaller gold coins, used principally for largesse at festivities.

The Star-pagoda, the usual gold currency, was of button-shape, with a star on the convex surface, a Hindu deity on the flat. It weighed 52½ grains, the same weight as the Roman denarius, the Arabic dinar, and the Venetian zechin, but it was only 19½ carats fine. The E.I.C. coined pagodas of lesser weight, about 46 grains, but of English standard fineness. They also coined silver fanams, 42 being nominally equivalent to the pagoda. These weighed 15 grains, so that they were equivalent to $\frac{1}{12}$ of the 180-grain rupee, to $1\frac{1}{3}$ anna, or to 4 copper pysa. So there was in the Madras Presidency a double monetary series, based on the gold pagoda and on the silver rupee, the relative value of these coins being of course inconstant. Gradually during the nineteenth century the gold standard was

replaced by silver, the change taking the following order:

1. The Pagoda of 42 fanams of 8 pysa of 4 kásh.

The Rupee of 12 fanams.

2. Then the two-anna piece replaced the fanam, taking its name.

The Rupee of 8 fanams, of 6 pysa, of 4 kásh.

3. The Rupee of 16 annas, of 3 pysa, of 4 kásh.

4. The Rupee of 16 annas of 4 quarter-annas (called $\frac{3}{4}$ pysa by the natives) or of 12 kásh improperly called 'pies.'

The division of the rupee into 8 fanams of 24 kásh survives, or did survive till quite recent years, in the French settlements of Pondichery, &c. The reason alleged was that the anna is non-existent as a coin. But it is curious that the French administration did not discover that there was a decimal system connected with the rupee. For in Southern India thirty years ago, and perhaps at the present day, the pysa was $=\frac{1}{3}$ anna and the half-pysa $\frac{1}{6}$ anna, but these were always reckoned among the people as $\frac{1}{50}$ and $\frac{1}{100}$ rupee.[1] To the people of the South the rupee is divided into 5 fanams each of 10 pysa each of 3 kásh. But the term kásh (kássu) is merely a name for the lowest coin. The E.I.C.'s pysa of 1808 bears the Persian inscription *Bis kás chhar fleūs ast* (It is 20 kásh, 4

[1] This obvious decimal system of a rupee divided into 10 lesser fanams and 100 pysa would not have appealed to French officials. It is not a decimal system, but the Metric system, that the French scientist requires; the decimal series of measures is only a stalking-horse for the French system abroad. The French do not as a rule care about using it themselves.

filus), followed by ' XX cash.' So this coin, so dear to the people of Southern India that they cannot look on the modern quarter-anna (the Anglo-Indians' ' pice ') otherwise than as a *mookal*, a $\frac{3}{4}$ pysa, is really 20 kásh, and the rupee is 200 filūs or 1000 kásh. Here is a decimal division ready for the rupee, for the half-pysa, nominally $\frac{1}{96}$ rupee (in 1797 coins it is so inscribed ' 96 to one rupee '), but $\frac{1}{100}$ rupee in the bazaar, is similarly inscribed as of ' 10 kásh 2 filūs.' So the rupee could easily be made of 10 fanams, 100 lesser pysa, 1000 kásh. But the sexdecimal division into annas, and the duodecimal division into pies, are too convenient to be given up for a decimal system.

The 2 filūs of the half-pysa show that the pysa was once divided into 4 of a small coin (the present pie), the *fils*, an Arabic word probably representing the L. follis.[1]

Indian Gold Coinage

Northern and Central India, the parts more immediately under the Mogul empire, were silver-standard countries. The silver rupee (sicca, = 192 grains) was the standard ; and the golden rupee of the same weight, called an Ashráfi, or gold mohur, was valued at 16 rupees, though generally more, according to the market-value of gold. The E.I.C. continued to strike gold mohurs, with halves, thirds and quarters. Other gold coins were current, notably the Venetian zechin,

[1] 1638. Fluces are 10 to a cozbeg (one halfpenny).—*N.E.D.* In this quotation it seems as if Sir T. Herbert had mistaken the filūs for the 10 kásh of the half-pysa.

and the approximate correspondence of this coin to the quarter-mohur caused the latter to be commonly known as a 'chick.'[1]

Southern India offers the curious instance of a gold-standard country (a century ago) having changed to a silver standard. The pagoda has disappeared in currency. The beautiful Farūki pagoda of Tippoo is still to be found; and the Venetian zechin with its archaic design, never changed since it was first struck in the thirteenth century, is highly esteemed in the household treasuries of affluent Indians for its great purity. The word zechin or sequin is derived from sikkah, 'coin.' The usual Persian inscription on the Mogul coinage, continued by the E.I.C., is *Shah Alam, bádshah ghází, sikkah mubárak* (Shah Alam, king victorious, coin auspicious).[2]

4. Decimal Currency

It is scarcely necessary to describe the decimal systems of which the Dollar currency is the type. They have some advantages in numeration with the counterbalancing defects of all decimal series. Division of the dollar stops at a quarter; then there is a drop to 10 cents, and that coin has no quarter. Any thirding can only be approximate.

[1] At whist, high play was for 'Rupee points and a chick on the rub.'

[2] The E.I.C. continued the custom of inscriptions on coins being in Persian, the polite language of Moslem India.

CHAPTER XIV

MEASURES OF TIME

THE primitive divisions of time were the day (the civil day between two sunrises or sunsets), and the lunar month taken as 30 days instead of the actual $29\frac{1}{2}$. Twelve lunar months made a calendar year of 360 days, to which were added, in ancient Egypt, five intercalary days. The additional day required every fourth year was called by the Romans *bissextum calendis*, as it was introduced by repeating the sixth day of the calends of March (our February 24).

From the 360 calendar days of the year was derived the division of the sun's apparent path on the ecliptic (and of every other circle) into 360 degrees. The ecliptic was divided, like the year, into twelve equal parts named from the constellations to which they corresponded; each of these was of 30 parts.

To avoid the intercalary days at the end of the ordinary year, these were afterwards distributed among the months in various ways. The number of days to each modern month is inherited, with some changes, from the arrangement adopted by a Greek-Asiatic

nation. The names of the months are those given by the Romans; their year originally began with March (as indeed did ours, on Lady Day, down to 1751), and the original names were:

Martius from Mars.
Aprilis from Aphrodite (Venus).[1]
Maius from *dü maiores,* the elder gods.
Junius from *dü juniores*, the younger gods.
Quintilis the 5th month, afterwards Julius.
Sextilis the 6th ,, ,, Augustus.
Septembris the 7th ,,
Octobris the 8th ,,
Novembris the 9th ,,
Decembris the 10th ,,
Januarius from Janus or Dianus, the sun-god.
Februarius from februum, the expiation month.

The week is of astrological origin. Even in Europe there are still many people who believe that the seven planets of the pre-Copernican system rule, each in its turn, the successive hours of each day; the planet ruling the first hour gives its name to the day, and influences it astrologically. Thus the week is the series of seven days ruled successively in the first hour by one of the seven planets. From the series of planets arranged in the order of their periods—Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon—the order of the day-names comes about in the following way:

[1] In the Bithynian calendar were a couple of months, *Areios* and *Aphrodisios* (once *Artemisios*), the Greek forms corresponding to Martius and Aprilis.

Sunday (*dies Solis*) was so named from the Sun ruling its first hour. The following six hours being ruled by the other planets, the Sun again rules the eighth hour, also the fifteenth and the twenty-second; the twenty-third hour is ruled by the next planet in the series, Venus;[1] the twenty-fourth by Mercury, and the first hour of the next day by the Moon, hence this will be Monday (*dies Lunæ*). The Moon ruling the first, eighth, fifteenth, twenty-second hours of Monday, the twenty-third hour will be ruled by Saturn (beginning the series again), the twenty-fourth by Jupiter, and the first hour of the next day by Mars; hence this day will be *dies Martis* or Tuesday, from the planet Tiw = Mars. And so on with the remaining days, the names of the planet ruling the next day being obtained by passing over the name of the two planets ruling the twenty-third and twenty-fourth hours. Thus beginning with the first planet of the series we get:

Saturn	ruling	Saturday	*dies Saturni*
Sun	,,	Sunday	,, *Solis*
Moon	,,	Monday	,, *Lunæ*
Mars (Tiw)	,,	Tuesday	,, *Martis*
Mercury (Woden)	,,	Wednesday	,, *Mercurii*
Jupiter (Thor)	,,	Thursday	,, *Jovis*
Venus (Frigu)	,,	Friday	,, *Veneris*

Latin Christianity made only two changes: *d. dominicus* for Sunday, and *d. sabbati* for Saturday;

[1] In the *Knightes Tale* (Chaucer) Palamon visits the temple of Venus at her hour, then the temples of Diana (the Moon) and of Mars at their respective hours.

but the latter still retains its old name in several countries, thus:

Provençal.	Welsh.
Dimenche	Dydd Sul
Dilun	,, Llyn
Dimars	,, Mawrth
Dimècre	,, Mercher
Dijòu	,, Jau
Divèndre	,, Givener (Wener)
Dissate	,, Sadwrn

The unit of time is the mean solar-day, the time between the noons of two successive days, noon being taken as the moment of the passage of the sun over the local meridian, corrected by the equation of time or daily correction required to reduce the varying solar days to a mean of all the solar days. So 'mean time' is that of a well-regulated clock dividing the year into mean solar-days of 24 hours; there being 365 days, 5 hours, 48 minutes, 46 seconds, in the astronomical year.

It is probable that everywhere, in primitive times, both day and night would be divided, in southern countries at least, or at the equinoxes, into three watches of fairly equal length: the morning, midday, afternoon; and the evening, midnight and dawn. Each of these would become divided, with the rise of astronomical observations and the use of sun-dials, into fourths, making twelve hours for either day or night; twelve hours corresponding to the twelve months of the year or to the uncial divisions of other measures. The civil day would thus be of twenty-four

hours, grouped into watches of four hours or into the eight canonical divisions of the day. In medieval times midday was properly the hour of sexte, the sixth hour from prime, the third from tierce; but in course of time the ninth hour, nones, was shifted from 3 P.M. to midday, which thus became 'noon.'

But the original division of the day, probably Chaldæan, was strictly sexagesimal. It was divided into 60 parts (= 24 minutes), each part into 60, and this again into 60.

In medieval times the Sun's daily path was divided into 24 hours, each of 15 degrees; and each hour was also divided into 3 miles or mileways of 5 degrees (= 20 minutes). This division was connected with the popular concrete idea of time in which 20 to 24 minutes was the common unit. In India the popular unit is still the time required to boil a pot of rice (20 to 24 minutes) or do some similar domestic task. In the Middle Ages the Western unit was the time required to walk a mile, on medieval roads.

'And thogh I stonde there a myle' (Gower, 1390).

'And maketh every minute seem a myle' (Spenser, 1594).

Then the degree was divided sexagesimally into 60 minutes each of 60 seconds, as at present. These divisions were at first called scruples, from the above-mentioned division of the day into 60 scruples of 24 minutes (the ounce being divided into scruples each of 24 light grains). Here the scruple-sense of $\frac{1}{24}$ passes to $\frac{1}{60}$.

'1610. The latitude fiftie degrees and fortie scruples or minutes' (Quot. *N.E.D.*).

o

The hour was also divided similarly into 60 scruples or minutes, each of 60 second scruples or seconds.

The ounce and scruple division of time is shown in the following passage from 'Le Breviari d'Amor,' a thirteenth-century poem by Ermengaud, a monk of Beziers. I have freely translated it from the Languedocian. 'The day is divided into quarters, each of 6 hours; and the fourth part of an hour is a point, the tenth part of which is a moment; the moment is divided into 12 parts called ounces, and each of the ounces yields 47 atoms, which time called an atom cannot be further divided.' It seems almost certain that 'atomus xlvij' is either a mistake for xlviij or deliberately put for *set* (7), to rime with *ret* (yields). The ounce of time, $= 7\frac{1}{2}$ seconds, would be divided into 24 scruples and 48 oboli, called atoms as being the end of the division. Similar dropping of a unit from Roman numerals is to be found in medieval Acts of Parliament and Ordinances.

The Lunar Year

In the lunar year used by Moslems and Jews, and also recognised by law in the movable date of Easter and some other feasts, the month is approximately of $29\frac{1}{2}$ days, so that the year is 354 days, less than the solar year by 11 days, or 12 in leap years. Hence Moslem feasts or fasts, such as the Ramadán and the times of pilgrimage, are that number of days earlier each year.

The age of the Moon is found by the Epact, its age on the first day of the year. It is about the same on March 1 as on January 1, owing to January and

February being together equal to two lunar months. So the increase of the epact during the year, at the rate of about one day in the month, begins March 1; and September is, for this purpose, the seventh month.

To the day of the month add the Epact and the number of the month, beginning March 1. The total, over 0 or over 30, is the age of the moon.

Example.—September 10, 1910 (7th Month), Epact for 1910 being xix.

$10 + 19 + 7 = 36$. The Moon was 6 days old.

What will be the date of full moon, its fifteenth day, in November 1912? November is the ninth month and the Epact for 1912 is xi.

$11 + 9 = 20$. $45 (= 30 + 15) - 20 = 25$. *Ans.* November 17.

Agriculturists who believe that certain seeds should be sown, trees planted, and pigs converted into bacon during the waxing of the moon, while trees are felled during the waning, find the Epact useful in reckoning the moon's age. It is also useful in calculating whether country-roads will be moonlit during certain nights.

The Epact increases 11 days annually: 1911, 0; 1912, xi; 1913, xxij; coming back to 0 in 31 years.

The Compass Card

While the circle of the horizon is divided into 360 degrees for astronomy and for accurate navigation, the steersman has always divided it sexdecimally. The temple of the Winds at Athens was octagonal; and the points of the horizon were named after the eight winds, a number increased to sixteen about the

time of Ptolemy. The Romans tried in vain to substitute an uncial division; their 12 winds and points could not supersede the 8 winds and points of the Greeks. And to this day in the Mediterranean there are 8 principal points, named after the sun and winds:

Tramontano, Levant, Mezzodi, Ponente.

Greco, N.E.; Scirocco, S.E.; Libeccio, S.W.; Maestralo, N.W.

Amerigo Vespucci sailed for the '*Ponente una quarta di Libeccio*,' West, one point S.W.; and afterwards for the '*Libeccio una quarta del Mezzodi*,' S.W. one point S.

DIAGRAM INDICATING THE PLANET RULING EACH HOUR,
FROM
DE TEMPORUM COMPUTATIONE ATQUE DIVISIONE,
Joannis Padovanii, Veronæ, 1577.

CHAPTER XV

MEASURES OF HEAT AND OF DENSITY AND COMPOUND INDUSTRIAL UNITS

1. Measures of Heat

Thermometric Scales

About 1595 Galileo made a thermometer, probably one with an air-bulb in which expansion of the air forces water down the tube.

Isaac Newton made an oil-thermometer with a scale of 12° between freezing-point and body-heat.

Fahrenheit, about 1714, made a mercurial thermometer, its 0 at the cold produced by a refrigerating mixture and 24° at body-heat. On this scale, freezing-point was 8° and boiling-point 53°. The quarter-degrees were then made whole degrees, producing the Fahrenheit scale with 32° for freezing-point, 96° (more correctly 98·4°) for body-heat, and 212° for boiling-point at ordinary atmospheric pressure. There are 180° between freezing and boiling points.

Réaumur's scale has 80° between these points.

Celsius (of Upsala, 1742) used a scale of 100° between these points. Hence it is usually called

Centigrade. This is the scale of international physical and chemical reports; and is generally used in laboratory-work.

The maximum density of water is at 4° Centigrade = 39·2° F.

The Fahrenheit scale is generally used in English-speaking countries. It is convenient for meteorological purposes as there is rarely any need to use 'minus' degrees for winter temperatures as in the Centigrade and Réaumur scales. For medical purposes it is also more convenient to have the normal body-temperature at 98·4° F. (close to 100°), than at 36·9° C. or at 29·5° R.[1]

To convert Centigrade degrees into Fahrenheit: Double the degrees; deduct $\frac{1}{10}$; add 32°.

E.g., 20° C.; $20 \times 2 = 40$; $40-4 = 36$; $36 + 32 = 68°$ F.

To convert Fahrenheit degrees into Centigrade: Deduct 32°; double the degrees; add $\frac{1}{9}$ (roughly $\frac{1}{10}$ or a little more).

E.g., 100° F.; $-32 = 68$; $\frac{1}{2}\,68 = 34$; $34 + 3{\cdot}4 = 37{\cdot}4$ (37·75 correct).

2. Measures of Density

Specific gravity and the density of fluids at different temperatures were known in very ancient times. The 'Eureka' experiments of Archimedes are well known. Al-Khazini (1121)[2] determined the

[1] Normal-body temperature is taken in France as 37° C. In Germany it is taken as 29·3° Réaumur = 97·9° F.

[2] *Book of the Balance of Wisdom* (H. Carrington Bolton).

specific gravity of metals and of fluids at different temperatures as accurately as modern physicists have done.

The hydrometer, divided into 24 qiráts, was well known in the East, even before the time of the Caliphates.

The density or specific gravity of solids and fluids is usually referred to that of distilled water at 62° F. = 16·6° C.

It is sometimes referred to 4° C. = 39·2° F. There is no advantage in this temperature, that of water at its maximum density; corrections for temperature will always have to be made in exact determinations, while, in the approximate determinations of trade, the indoor standard of 62° F. requires no correction.

The specific gravity of gases being in the ratio of their molecular weight, which is referred to that of hydrogen, this gas is taken as the standard.

The density of solutions of salts, sugar, acids, &c., is referred to that of water or stated on a trade-scale usually indicating the percentage in solution.

The density of spirits is referred to that of water, but their alcoholic strength to:

(*a*) A scale indicating the volume of alcohol per cent. (Gay-Lussac and Tralles).

(*b*) An arbitrary scale (Cartier and Baumé).

(*c*) An excise-scale on the basis of proof-spirit (Sykes).

Proof-spirit meant originally a spirit sufficiently strong to take light, and which, if poured on gunpowder and lighted, would cause the powder to explode. This

was the 'Holland-proof.' By a statute of 1816 it was defined as of specific gravity $\frac{12}{13}$ that of water at 51° F., which is = 0·923; but at the present standard temperature of 60° = 15·5° C. it is 0·920.

With Sykes's hydrometer, used in England:

Under Proof (U.P.)—each degree means 1 per cent. of water, the rest being proof spirit.

Over Proof (O.P.)—each degree means 1 per cent. of water required to be added to bring the spirit down to proof.

The scale of Tralles's alcoholometer only differs from Gay-Lussac's by water being taken at 39·2° and pure alcohol as of sp. gr. 7939 at 60°.

Sp. Gr.	Alcohol Vol. per cent.	Sykes° (Excise)	Baumé° (French)	
1·000	0	100 U.P.	10	
0·920	57·05	Proof	22	
0·848	85·2	49·6 O.P.	36	Fr. Rect. Spirit, Trois-six.
0·838	88·8	55·8 ,,	38·2	Rect. Spirit, Brit. Pharm.
0·821	93·75	64·3 ,,	41·8	Strongest Rect. Spirit.
0·794	100	—	48	Absolute Alcohol.

The approximate relation of the five usual scales for proof and French rectified spirit are as follows:

	Proof 0·920	Fr. Rect. Sp. 0·848
Gay-Lussac	58°	86°
Tralles	56·3°	85°
Cartier	21·6°	34°
Baumé	22·6°	36° Trois-six
Sykes	Proof	49·6°

Compound Industrial Units

Units of Power, of Electricity, of Caloric, &c., are abstract compound units based on units of time, weight, length, &c., combined for industrial convenience, e.g. a certain weight moved a certain distance in a certain time.

The H.P., engine horse-power, is 550 lb. raised one foot in one second. In France this becomes 75·9 kilos, raised one metre in one second, = about ¾ of the kilo-watt unit of electric power.

CHAPTER XVI

THE ELLS

THE Ells are the Cubits of the modern West. They are of two kinds: the Foot-Ells, of which the Persian cubit and the Belâdi cubit, divisible into 2 feet, were the types, and the Span-Ells, of 3, 4, 5 or 6 spans.

1. THE FOOT-ELLS

In France the Aune was 4 Roman feet.

In the Italian states the Braccio was usually 2 local eet, but sometimes an Eastern cubit.

In the German and Norse states the Eln was 2 local feet.

In Spain the Covado, of 2 Burgos feet, was the Belâdi cubit.

2. THE SPAN-ELLS

The Span-Ells of Western Europe are of two types, derived either from the English foot, or from a Netherlands foot which has disappeared and which was probably the Olympic foot. (See Holland, in the next chapter.)

The Netherlands Ell appears then to be 3 spans of an Olympic cubit $= 3 \times \frac{18 \cdot 24}{2}$, which is equivalent to $2\frac{1}{4}$ Olympic feet: $2\frac{1}{4} \times 12 \cdot 16$: both $= 27 \cdot 36$ inches. The Antwerp Ell was formerly $= 27 \cdot 396$ inches, and that of Amsterdam $= 27 \cdot 216$ inches. There has been shrinkage, probably through the influence of the English standard of the Flemish Ell, we having taken 3 of our own spans, $= 27$ inches, for this largely used trade-measure, and our standard having prevailed in foreign trade. So the Flemish Ell has tended more and more to the English standard. In Holland and its colonies it is $= 27 \cdot 08$ inches. This is also the standard in Portugal. The lesser *pík* or *drá* of Constantinople, $= 27$ inches, was probably $= 26 \cdot 8$ inches as in Egypt; it may have increased under the influence of the English or Flemish Ell. The Venetian braccio, $= 26 \cdot 9$ inches, probably comes from this Turkish *pík*.

In Northern France there was an Aune $= 27 \cdot 1$ inches and another of 27 Amsterdam inches $= 27 \cdot 36$ inches (the Amsterdam foot being of 11 inches).

In Prussia there is, or was, an Ell $= 26 \cdot 257$ inches. It was described as of $2\frac{1}{8}$ Rhineland feet; but it was almost certainly 3 Roman spans $= 2\frac{1}{4}$ Roman feet ($11 \cdot 67 \times 2\frac{1}{4} = 26 \cdot 257$ inches), brought into the Rhineland system by representing it as $2\frac{1}{8}$ Rhineland feet, which it is only approximately; $2\frac{1}{8} \times 12 \cdot 3563$ being $= 26 \cdot 2617$ inches.

Nowhere out of England and Scotland is there found any Span-ell other than of 3 spans. The

apparent exceptions are in Spain, where the Vara of 3 feet, = $1\frac{1}{2}$ Beládi cubit, is a 4-span ell, like our Yard, and in Occitania (Southern France), where the Cano is an 8-span fathom.

'Ell,' formerly Elne, meant at first the natural cubit or length of the forearm (L. *ulna*) from the finger tips to the bend of the arm or 'el-bow.' Originally of 2 spans, it came to mean a greater multiple of the span, or, as in the case of the German ells and the French aune, a multiple of the foot.

Our Ells were:

Flemish Ell . . .	3 spans	= 27 inches	
English Yard . . .	4 ,,	= 36 ,,	
Scots Ell . . .	4 ,,	= 36 ,,	(Scots)
English Ell . . .	5 ,,	= 45 ,,	
Long English Ell or Cloth-goad	6 ,,	= 54 ,,	

The Flemish Ell was that of the Netherlands, brought to the standard of our inches.

The Long English Ell or cloth-goad of 6 spans was a double Flemish ell. It has long been extinct.

The Yard has survived, from its convenience as either of 4 spans or of 3 feet.

The Scots Ell = 37·058 inches corresponded to the English yard; it was 3 feet Scots, i.e. of Rhineland standard, = 12·353 inches.

The Common English Ell, the tailor's yard, 'taylors yerde, virga cissoris,' was probably the French aune = 46·6 inches, introduced under the Plantagenets from their French dominions and cut down to fit our ell system. This ell appears to have been carried abroad by trade. Both the 3-span Covado and the

5-span Vara of Portugal are identical with our ells, their spans being longer than the ordinary Portuguese spans and called *palmos avantejados*, long spans.

The four-foot Ell of Jersey and Guernsey was probably the French ell increased from 4 Roman feet to 4 English feet.

Of the foot-ells of Italy and Germany, several were exactly half our ell, while quite foreign to the native standards.

Both our Ell and our Yard were divided into 4 quarters and 16 nails. The Elizabethan standards, still extant, are so divided.

Of the English span-ells the Yard alone remains. The 5-span Ell, maintained by the statute authority which prescribed the breadth of cloth, lived only as a royal measure and, like the royal pound, was gradually superseded by the more popular measure. The ell was obsolete nearly a century before the royal pound silently disappeared. It seems, however, to have survived in Wales for a long time.

CHAPTER XVII

FOREIGN LINEAR MEASURES

ONLY a sketch of these can be given, for in some countries so various are the local standards that each petty state, each district sometimes, would require a long study.

1. THE TEUTONIC COUNTRIES

Sweden

The Roman foot = 11·67 inches. This is, or was, also used in Oldenburg and in some parts of Holland.

Denmark and Norway

The Rhineland foot = 12·356 inches, divided into 12 Tomme (thumbs), 12 feet = 1 rode (rod).

North Germany

The principal types are :

1. The Rhineland foot, in Prussia, &c.

2. The Hanoverian foot = 11·5 inches more or less, used in Hanover, Pomerania, part of Holland and Belgium, Bavaria, Mecklenburg, and Geneva.

3. The Hanseatic foot, 11·32 inches more or less,

used in Lubeck, Bremen (11·39), Hamburg (11·276), Dantzig, also in Hesse, Saxe-Coburg, and Poland.

The length of 11·32 inches points to the probability of the Hanseatic foot being a reduced Rhineland foot, $\frac{11}{12}$ of 12·356 inches = 11·3264 inches. There are several instances of the popular objection to a long foot and of the artifice which reduces it to a more convenient length by taking 11 inches of the government standard, and making from them a foot of 12 short inches.

4. The Amsterdam foot = 11·146 inches, also used in the Dutch parts of New England. This foot is divided into 11 inches, an evident instance of a reduced foot, unconcealed by any division into 12 new inches. The practice of making a reduced foot stands revealed, and is confirmed by the Amsterdam rod (roede) being 13 of these reduced feet, evidently to make up in land-measure for the reduction in the foot in the home and in the workshop. This compensation is of the same kind as that now used in English agricultural weights where, to compensate for the statute reduction of the ancient 16 lb. stone, of which 16 made a wey or load of 256 lb., the custom arose of taking 18 statute-stones of 14 lb. to make a load of 252 lb. approximately the same as the old load.

The question now arises: What was the foot of 12·16 inches which the Hollanders reduced to $\frac{11}{12}$ = 11·146 inches? Was it the Olympic foot?

The seafaring Netherlanders, to whom the nautical mile and its $\frac{1}{1000}$ part = the Olympic fathom, were familiar, would very possibly take its sixth part as their foot, just as the seafaring Greeks had taken it.

But landfolk accustomed to the short Roman foot, which is still to be found in the land-measures of Holland, would reduce the longer foot to 11 inches for popular use.

Yet the longer foot has left traces in the Netherlands. The Amsterdam roede of 13 Amsterdam feet is = 12·07 feet, i.e. 12 feet of 12·07 inches. The Amsterdam Ell, = 27·08 inches at present (= 3 spans of 9·023 inches), was, in 1647, according to John Greaves, = 27·216 inches, giving a foot of 12·1 inches, and he gives the Antwerp Ell as = 27·396 inches, which gives an Antwerp foot 12·176 inches, a length very close to that of the Olympic foot of 12·16 inches. There appears to have been a slight shrinkage in the Amsterdam ell.

Austria

There are two standards of foot. While the ordinary foot, $\frac{1}{6}$ of the Klafter or fathom, is = 12·441 inches, that of the ell (which is $2\frac{1}{2}$ feet) = 12·245 inches. It looks as if the one were increased, and the other equally decreased, from the Rhineland foot, = 12·356 inches.

2. The Latin Countries

Italy

Here every state, almost every city, had a different standard of length. The foot was generally of Roman type = 11·67 inches, or of a very short type, = about 10·3 inches, referable possibly to half an Egyptian royal cubit, = 20·64 inches, a measure still extant in

Egypt. There was usually also a braccio or cloth-ell of 23 to 26 inches, probably of Eastern origin.

In Lombardy the standard was the Luitprandi foot (pié Aliprandi) = 20·28 inches, with a corresponding pertica or rod of 12 *piedi*, usually = 20·23 feet. Legend refers this measure to the foot-length of a giant Lombard king; but it is evidently a cubit, probably a variant of the Egyptian royal cubit, for $\frac{2}{3}$ of it gave the Lombard foot, = 13·52 inches; and this, as also the Venetian foot, = 13·69 inches, seems referable to the Egyptian royal foot, = 13·76 inches.

But everywhere and always the people object to a long foot-standard. Whether in ancient Egypt or in modern Italy, they will take a more convenient length; they will halve the cubit so as to get a short foot, or take some span, or some ell divisible into spans. So in Italy there was generally a local foot and also a span. Sometimes the span was $\frac{3}{4}$ of the foot, at other times it was a fraction of a braccio or ell; and both foot and span might be called a *palmo*. This term was equivalent to the L. *palmus major* as distinguished from the ordinary *palmus* of 4 digits. In Rome there is, or was till recently, a series the same as that of ancient Rome, on the basis of a foot = 11·72 inches, slightly longer than the ancient foot = 11·67 inches; 5 feet made a *passo*, and 1000 *passi* a mile.

The foot was of 16 digits, usually called *oncie*, inches, and 12 of these digits were taken for a palmo = 8·79 inches. Three of these palmi made the braccio, the cloth-ell, = 26·38 inches.

The Roman field-measures were a mixture of

decimal chain-units and of lengths derived from seed-measures of land.

In Tuscany the standard was the braccio, = 22·98 inches, half of which was the palmo, = 11·49 inches. The braccio was divided, as if it were a money-pound, into 20 soldi, of 12 denari.

In the kingdom of Naples, with its population of Greek origin, the standard of length was the meridian mile, divided into 1000 Olympic fathoms or passi. But the passo was divided, not into six long feet, but, like the Egyptian royal cubit, into 7 palmi, = 10·4 inches. The usual standard was the Canna of 8 palmi, a reversion to the common Mediterranean measure of the reed of 8 spans.

In Genoa there was, and perhaps is still, a palmo = 9·764 inches, a length exactly that of the pán in several cities of Provence. It has changed but little since the time of Recorde's 'Pawn of Geans' (1543) or since John Greaves (1647) gave it as = 9·78 inches.[1]

Genoa, the language of which district is a dialect of Provençal, has measures of the Provençal type. The measures of Provence will be described at length in Chap. XXI.

Spain

The standard is the Burgos foot = 11·127 inches, 3 feet making a Vara. This foot was originally =

[1] In this 'pawn' (the spelling of which shows that English had already lost the *a* sound of the first vowel and had to represent it by *aw*) I see the fusion of two words etymologically different, the Italian *palmo*, L. *palmus*, and the Provençal *pán*, side, panel. See, in Chaps. IV and XXI, 'The Pán of Marseilles.'

10·944 inches,[1] i.e. half the Beládi cubit, brought by the Moors. This original standard has been preserved very nearly in the two-foot *Covado di ribera*, the shore-cubit, = 21·9157 inches, its half = 10·9578 inches.

That the Burgos foot has deviated, like most Spanish weights and measures, from the accurate standards of the Moors, is shown by the length of the Spanish *Legua maritima*, the league of 3 meridian miles, or 6653·36 varas. At the modern standard of the Burgos foot this is

$$6653{\cdot}36 \times 3 \times 11{\cdot}127 \text{ inches} = 220{,}958 \text{ inches},$$

while 3 meridian miles are

$$2026{\cdot}66 \text{ yards} \times 3 \times 12 \text{ inches} = 218{,}880 \text{ inches},$$

showing an error of 2078 inches = 57·7 yards.

Taking the original standard of the Burgos foot at 10·944 inches,

$$6653 \text{ varas} \times 3 \times 10{,}944 = 218{,}880 \text{ inches},$$

exactly corresponding to the Parasang, = 10,000 Beládi cubits of 21·888 inches, or to 20,000 Burgos feet as instituted by the Moors.

The erroneous standard of the Burgos foot appears to have been corrected. The tables of A. de Malarce, approved by the French government in 1879, give the Burgos foot as = 0·27833 metre = 10·938 inches.

That Spain also once had the Roman foot is shown by the survival in Tunis of the Drá Andalussi, the Spanish Ell, of 3 Roman spans of 8·753 inches = 26·25 inches.

[1] As pointed out by Don V. V. Queipo (*Essai sur les Systèmes Métriques*, 1859), but not quite accurately. His values are often confused or obscure, but his work is most useful.

Portugal

Here the Roman standard is seen in the Palmo or span = 8·749 inches, $\frac{3}{4}$ of a foot = 11·665 inches. The palmo is divided into 8 *polegadas*, inches, of 12 lines, or into 12 *dedo*, digits, of 8 lines.

The Vara, = 43·7 inches, is of 5 spans; the Braça, or fathom, is 2 varas or 10 spans; 3000 fathoms make a league, = 3·89 miles, divided into 3 *milhas* of 8 *estados*, stadia or furlongs. In land-measure 4840 square varas make a *geira* (= 1·47 acre) exactly, as 4840 square yards make our acre. One may infer that the form and division of the geira was similar to that of our acre; that it is, or was, 220 × 22 varas, a $\frac{1}{10}$ strip of some 'acreme' measure. This view is supported by the use in Brazil of a land-unit, the *quadro*, officially 150 × 1 metres; a strip of an original square quadro corresponding to the 10-geira field. In Argentina the *cuadra* is 150 varas, and the *cuadra cuadrada*, 4·17 acres, is that measure squared.

Portugal has another span, the *palmo avantejado* = 9·0256 inches, of which 3 make a covado or cubit = 27·078 inches, virtually the Flemish ell of English standard.

3. Russia and the East

Russia

The standard of length is the English foot, introduced by Peter the Great. There is another and older measure, the Arshīn = 28 inches, i.e. the Turkish arshīn of 27·9 inches varied to a simple relation with the

new foot; and like the Turkish measure it is divided into 16 nails (Verstok). See 'Arshīn,' further on.

3 Arshīns = 1 Sajeng = 7 feet.
500 Sajeng = 1 Verst = 1166·6 yds. (1·06 kilometre).

Turkey

The Arshīn or Halebi pík = 27·9 inches.

$5\frac{1}{2}$ Arshīns = 1 Qasáb.

The Hendázi or Stambūli *drá* = 25·688 inches, very nearly the Hashími cubit = 25·56 inches.

The Cloth-drá = the Flemish ell.

All these are divided into either 16 nails or 24 qirát.

Egypt

The Hendázi drá, as above.

The Nile pík of two standards:

1. That of the Black cubit = 21·28 inches.
2. That of the Royal cubit = 20·65 ,,

There is also a commonly used pík = 26·8 inches, probably a low standard Flemish ell.

Persia

The geodesic traditions of the ancient Oriental monarchies maintain many of their standards. The principal is the Guz or Yard of 2 common Egyptian cubits $2 \times 18{\cdot}24 = 36{\cdot}48$ inches. It is $\frac{1}{6000}$ of the Farsakh, the ancient Parasang or league of 3 meridian miles.

There are also amongst others:

A Cloth guz = $1\frac{1}{2}$ Hashími cubits = 38·3 inches.
Another guz = $1\frac{1}{2}$ Persian cubits = 37·9 ,,
,, ,, = $1\frac{2}{3}$ Hashími cubits = 42 ,,

Roumania

The measures differ little from those of Turkey.
The Halebi pík = 27·6 inches.
The Hendázi ,, = 26·03 ,,

Greece

The Hendázi *píchus,* of Hashími standard = 25·51, is the usual measure.

Tunis, Tripoli, Algeria

The Moorish drá = 18·94 to 19·2 inches (¾ of the Hashími cubit), the usual standard. The multiples by 8 show the influence of the Cano of 8 spans from Southern France and Italy.

The ancient Roman mile still exists in Tunis, with a length = 1610¼ yards.

4. The Hashími Cubit

After the Moslem conquest of the countries of the Eastern great monarchies, the 25·26 inch standard of the Persian cubit was raised to 25·56 inches. This is the Hashími, or Hashemic cubit, named after Hashim, the chief of the Arab tribe to which the prophet Mahomed belonged. It is the cubit mentioned in the 'Arabian Nights' (524th night). But the cubit or the foot of the Nights, when not specified, is usually either of the Olympic or of Al-Mamūn's standard. The increase of the Persian cubit was probably to bring it, together with the Beládi cubit and the Arshīn (to be described presently), into simple relation with a Qasáb of length slightly increased so that this should,

for building and land measurement, be a common multiple of the three cubits. This is the Turkish qasáb, the qasáb qabáni = 153·45 inches.

7	Beládi cubits	at	21·888	inches	= 153·216	inches.
6	Hashími	,, ,,	25·56	,,	= 153·36	,,
$5\frac{1}{2}$	Arshīns	,,	27·9	,,	= 153·45	,,

By taking the 7 Beládi cubits at the equatorial standard of the Jewish cubit, 21·914 inches, they would give 153·34 inches, and taking $5\frac{1}{2}$ arshīns at the slightly diminished length of 27·88 inches, the qasáb would be an exact common multiple of them at 153·36 inches.

This qasáb can be divided into 6 Hashími cubits, or 12 feet, or 24 kubdehs (handshafts), or sexdecimally into 2 fathoms, 4 guz, 8 cubits, 16 spans. It is a mere coincidence that the old French foot, = 12·789 inches, was very approximately half a Hashími cubit.

5. The Halebi Pík or Arshīn

The date of this measure is as uncertain as its source. It is a Turkish measure = 27·9 inches or thereabouts, divided into 16 qirát. This division points to it being $\frac{2}{3}$ of a Persian guz of 24 qirát.

Among the guz of Persia there is one = $1\frac{2}{3}$ Hashími cubits = 42 inches, of which $\frac{16}{24}$ = 28 inches. If this length were taken, it might have been somewhat lessened to make it an aliquot part of the Turkish reed or qasáb, 6 Hashími cubits = 153·36 inches. At the length of 27·9 inches, $5\frac{1}{2}$ arshīn = 153·45 inches or within $\frac{1}{10}$ inch of the qasáb.

It is curious that the Reed should be $5\frac{1}{2}$ arshīns, as our Rod is $5\frac{1}{2}$ yards.

While the Turkish qasáb is—

7 Beládi cubits, 6 Hashími cubits = $5\frac{1}{2}$ arshīns, the Egyptian qasáb, somewhat less, is—

6 Assyrian cubits of 25·26 inches = 151·56 inches, or $5\frac{1}{2}$ double royal feet of 13·76 = 151·36 inches, and is divided into 10 ' belendi ' feet of 15·156 inches.

There is a lesser Egyptian qasáb of 5 arshīns = 139·65 inches and a third still less, of 4 Assyrian cubits = 101 inches. With each of these qasáb 20 × 20 make a Feddan of land.

The word Pík is the Greek pichūs, a cubit.

Note of Acknowledgment

In this and the next two chapters I have necessarily had to work largely on materials gathered by others. The equivalents of foreign measures and weights are in many cases taken from—

Kelly's 'Cambist,' 1816.

Woolhouse's 'Measures, Weights and Moneys of all Nations,' 1890.

De Malarce, 'Poids et Mesures,' 1879.

Browne's 'Merchants' Handbook,' 1899.

The information in the last of these is excellently compiled and very trustworthy.

My object is to give, not tabulated series of measures but their history and rationale, to apprehend the ways

of thought which have given rise to them, to seek their relations. No country has an isolated system, or even an isolated measure, and unity underlies the infinite variety of measures and weights.

TABLE OF SOME EUROPEAN ITINERARY MEASURES

	Yards	Miles
1. Meridian mile—Naples . . .	2026⅔	1·1515
,, league, $\frac{1}{20}$ degree . .	—	4·54
2. Ancient Roman mile . . .	1621⅓	0·921
3. Roman mile, modified—		
Venice, 1000 paces of 5 feet . .	1901	1·08
Sicily, 720 rods of 8 palmi . .	1625	0·924
Spain, 1000 paces of 5 feet . .	1520	0·863
Portugal, 8 stadia of 234⅔ varas .	2281	1·296
England, 8 furlongs of 220 yards .	1760	1·0
France, 1000 toises . . .	2131	1·21
4. German Meile, about a meridian league—		
Austria, 4000 fathoms of 6 feet .	—	4·71
Prussia and Denmark, 2000 rods of 12 feet	—	4·68
Hanover, 1587 rods of 16 feet .	—	4·66
Brunswick, 1625 rods of 16 feet .	—	4·61
5. An ' hour-walk ' league—		
Holland—Uur gaans	—	—
Switzerland—Stunde, 1600 rods of 10 feet	—	2·98
6. Russia—Verst, 500 sajeng of 7 feet .	1166·6	0·663

CHAPTER XVIII

FOREIGN WEIGHTS

1. Teutonic Systems of Weight

The German and Norse pounds are of three types:

1. The pound of the Cologne mark, the double marc, = 7216 grains, its ounce = 451 grains. This was the standard of the old Tower weight of the English mints. It coincides with the Arabic lesser rotl, $\frac{1}{100}$ of the Cantar of Al-Mamūn (= 102·92 lb.).

Its modern type is, or was, the pound of Prussia and Hanover = 7218 grains, $\frac{1}{100}$ of the Centner = 103·11 lb. It was defined as $\frac{1}{66}$ of the weight of a Rhineland cubic foot of water (see next chapter).

2. The Troy pound, of variable standard, from 7705 grains (ounce = 481·5 grs.) in Denmark, and as high as 483 grains in Sweden, to 7595 grains (ounce = 474·7 grs.) in Holland. Even in Holland there is another standard, that of the Amsterdam pound, 7625 grains (ounce = 476·7 grs.), the medium standard of Troy weight, = 10 Egyptian dirhems of 47·6 grains.

3. The Nuremburg pound = 7390 grains, its ounce = 462 grains. As the 12-oz. pound of apothecaries' weight, it is = 5522 grains, its ounce = 460·2

grains. This pound is derived from the 8-ounce *peso di marco* of Venice = 3695 grains. The Venice ounce, = 460·2 grains, was divided into 144 carats of 3·19609 grains. This ounce was 8 centesimal drachmæ of the Arabic lesser rotl = 5763 grains, when divided on the Greek system into 100 drachmæ of 57·63 grains, instead of on the uncial system, so that 8 × 57·63 = 461·04 grains. This is the apparent basis of the Venetian marc-ounce and the Nuremburg ounce.

As the Marc was ⅔ of the classic 12-oz. pound, the word came to mean ⅔ of a pound, either weight or coin; it probably came from 'San Marco' of Venice.

German and Scandinavian ounces were usually divided into 2 loths or half-ounces, 8 quentchen and 16 Pfenning.

In Holland the mint-ounce was of 20 Engels, each of 32 Azen. 'Engel' is the English sterling or dwt.; the Aas is an ace, a light grain = 0·7417 grain.

The Baltic Skippund. This ship-pound was 20 lispund, of either 20 light or 16 heavy pounds:

Denmark & Norway—20 lispund of 16 skaalpund	= 352 lb.
Sweden—20 lispund of 20 skaalpund	= 375 lb.
Russia—the berkowitz, 10 pūd of 40 fūnt	= 361 lb.

2. East-European Systems of Weight

The Pounds of Poland, of Russia, of Austro-Hungary and Bavaria (also a mint-pound in Sweden), appear to have developed from the Arabic pounds on a dirhem-basis.

1. The Polish pound, 16 × 8 dirhems of 48·9

grains, = 6258 grs. It is divided into 16 ounces; the oz. = 391 grs. (Cf. the lb. of Sardinia and of Languedoc; the oz. = 392 grs.)

2. The Russian pound or fūnt, of 12 ounces. The ounce (lana) = 526·6 grains is almost exactly 10 greater dirhems of 52·6 grains.

This ounce is exactly that of the rottolo attári or Assyrian rotl of 8426 grains (the Greek-Asiatic miná) still extant in Bássora (Chaldæa) and in Algeria. The relationship is evident, since the Roman As was $\frac{1}{100}$ of the Greek-Asiatic talent, and the greater dirhem was $\frac{1}{9}$ of the As-ounce = 420·75 grains.

3. The Austro-Hungarian pound, also used in Bavaria, is 16 × 8 dirhems of 50·6 grains = 6482·3 grs.

4. The Swedish mint-pound.

This pound, = 6503 grains, was divided into 2 mint-marcs, divided again into 8 ounces of 406·3 grains. Of the same type is the commercial skaal-pund = 6536 grs.; its oz. = 408·5 grs., a weight exactly the same as that of the ounce of Genoa, which belongs to the dirhem-system, being 8 dirhems of 51 grains.

The Swedish medicinal weight is Nuremburg. There are two miner's pounds showing the extremes of Troy weight; the ounces being 483 and 471 grains.

3. The Mediterranean Systems of Weight

In Egypt the dirhem-system gives rise to two series of weights: that of the Oka and that of the Rottolo. In the latter word the Arabic 'rotl' is Italianised,

the Arabic weights having come under Roman influence; an influence of long standing, since Al-Mamūn divided the Cantar after the Roman plan into 125 lesser rotl as well as into 100 greater rotl, when the Arabic gold Mithkal, $\frac{1}{72}$ of the Egypto-Roman libra, took the place of the exagium solidi or aureus, $\frac{1}{72}$ of the Roman mint-As.

The Mithkal, or Miskal, = 72·74 grains, was divided into 24 Egyptian qirât = 3·03 grains, as the Aureus had been divided into 24 Roman Siliquæ = 2·92 grains, and 16 of the 24 qirât was the standard of the silver dirhem = 48·5 grains, *the lesser dirhem.*

The golden Dinar, $21\frac{3}{4}$ qirât, was of the weight of the Attic commercial drachma = 65·6 grains; it displaced the Roman golden denarius. But the lesser dirhem, $\frac{2}{3}$ the weight of the Mithkal, did not succeed in displacing an old-established drachma, which became a greater dirhem. For, as the Mithkal had a dirhem $\frac{2}{3}$ of its weight, so the Roman Aureus, $\frac{1}{6}$ of the As-ounce, had a silver drachma $\frac{3}{4}$ of its weight. The As, originally $\frac{1}{100}$ of the Greek-Asiatic talent, had its ounce divided, after the Greek system, into 8 drachmæ each $\frac{5049}{12 \times 8} = 52{\cdot}6$ grains. Apparently this *greater dirhem* tended, in Arab times, to fall towards the standard of the lesser dirhem = 48·5 grains. This is the probable explanation of the variations of the dirhems, and of the pounds based on them, along the Mediterranean coasts.

In Tunis the dirhem = 48·58, almost exactly the original weight of the lesser dirhem. But in Tripoli

there are two standards, 47·075 and 50·1 grains. The Ukyé or ounce is goldsmith's weight, 10 dirhems of 47·075 grains; but in commercial weight it is in dirhems of 50·1 grains, so it is made the same weight by reckoning it as 150 kharūb or qirát instead of 160 of these as in the goldsmith's ounce of 10 dirhems of 16 qirát.

So there are variations in the weight of the dirhem basis of the Mediterranean pounds:

In Egypt the dirhem		=	47·66 grains
In Tripoli	,,	=	47·07 ,, 50·1 ,,
In Tunis	,,	=	48·58 ,,
In Morocco	,,	=	49 ,,
In Turkey	,,	=	49·6 ,,

The qirát, $\frac{1}{16}$ of the dirhem, varies with it.

Egypt

The Oka, = 2·723 lb., is 400 dirhems of 47·66 grs.
The Rottolo, = 98 lb., is 144 ,, ,, ,,
The Oka is a centesimal multiple of the dirhem.
The Rottolo is an uncial multiple of it.

100 Rottoli = 1 Cantar = 98 lb.; this is the modern Egyptian Cwt. which has succeeded the Cantar of Al-Mamūn = 102·92 lb.

Turkey

There is a double series as in Egypt, but the Turkish series are based, one on the Dirhem and the other on the Egypto-Roman ounce at the standard of 436·45 grains. In modern Rome it is 436·26 grains, in Tuscany 436·66 grains.

The Dirhem, = 49·5 grains, is 16 qirât of 3·1 grains.

The Cheké is of 100 dirhems = 4950 grains.

The Oka is of 400 dirhems = 2·83 lb.

The Cantar is = 2000 ounces = 124·7 lb. or 44 Oke. The Cantar is divided into 100 Rottoli of 1·247 lb., = 20 ounces.

The Libbra and the Rottolo

Rottoli of over 16 ounces are not uncommon in Mediterranean countries, whether Moslem or Christian. They form an alternate series with the libbra series. Thus in Algiers there are 3 rottoli of 16, 18 and 24 oz., each ounce, = 526·6 grains, being 10 greater dirhems, and coinciding with the Russian ounce. There are—

in Sicily a 12-oz. libbra, = 4897 grs., and a 30-oz. rottolo = 12,244 grs.;
in Malta a 12-oz. libbra, = 4886 grs., and a 30-oz. rottolo = 12,215 grs.;
in Genoa a 12-oz. libbra, = 4893 grs., and an 18-oz. rottolo = 7378 grs.;
in Naples a 12-oz. libbra, = 4950 grs., and a rottolo = 13,750 grs.

These Italian libbre belong to the dirhem system, their ounces being 8 dirhems of slightly different weights; and the ounces are of much lower weight than the ounces of the northern countries or of ancient Rome. Though divided into 12 ounces, these libbre belong to the same class as the 16-oz. pounds of Southern France; all having ounces of 8 dirhems. But in North Africa the Oka and the rottolo have an ounce of 10 dirhems.

Ounces and Dirhems of the Mediterranean System

	Lb.	of Oz.		Dirhem of
Genoa	12 oz.	408·5 grs.	$\frac{1}{8}$ = 51	grs.
Sicily	,,	408 ,,	$\frac{1}{8}$ = 51	,,
Malta	,,	407 ,,	$\frac{1}{8}$ = 51	,,
Sardinia	,,	392·6 ,,	$\frac{1}{8}$ = 49·1	,,
Majorca	,,	392 ,,	$\frac{1}{8}$ = 49	,,
Languedoc	16 oz.	400 ,,	$\frac{1}{8}$ = 50	,,
Gascony	,,	392 ,,	$\frac{1}{8}$ = 49	,,
Provence	,,	377 ,,	$\frac{1}{8}$ = 47·1	,,
Turkey			= 49·5	,,
Egypt			= 47·66	,,
Morocco Rotl	20 oz.	392 ,,	= 49	,,
Tripoli Oka	40 oz.	470·75 ,,	$\frac{1}{10}$ = 47	,,
Algiers Rotl	16 oz.			
Tunis Rotl	16 oz.	485·8 ,,	$\frac{1}{10}$ = 48·58	,,

Everywhere there is a Cantar or Quintal, a hundredweight, divided into 4 *ruba* and into 100 pounds or rotl.

In Tunis the Cantar = 111 lb., divided into 100 rotl of 16 ukyé or ounces of 10 dirhems.

In Tripoli it is = 107·6 lb., in 100 rotl of 16 ukyé, of 8 dirhems of 47·075 grains.

In Morocco it is = 112 lb. of 100 rotl, each of 20 ukyé of 8 dirhems; the ukyé or ounce = 392 grains as in Gascony (Foix, Albi, &c.), where it was 8 ternau.

SUMMARY

However differently the Mediterranean pound or the rotl may be divided, its ukyé or ounce is always

based on one of the dirhems. This dirhem-basis is found in every pound used in Europe and the countries colonised from Europe.

The pound, whether of 12 or 16 ounces, found in Morocco, Majorca, Sardinia, Gascony, is then an Arabic weight, with an ounce of 8 dirhems, of 49 grains = 392 grains.

The pound of Provence was 16 ounces, each 8 dirhems of 47·1 grains.

The Troy pounds had ounces of 10 dirhems varying between 47·2 grains for French Troy and 48·3 for northern Troy.

The Spanish pound = 7101 grains, its ounce = 443·8 grains, was originally at the Moorish standard of 6 mithkals to the ounce, that is the Egypto-Roman ounce, the old averdepois ounce. But 6 mithkals being equal to 9 lesser dirhems, this dirhem-basis appears to have been taken. Then, for lesser dirhems of 48·5 grains, 9 heavier dirhems of 49·3 grains, nearly the Morocco and Gascony standard, were substituted.

The Nuremburg or Venetian pound. Its ounce, = 460 grains, was 12 drachms of 57·6 grains, $\frac{1}{100}$ of the lesser rotl.

The Cologne pound of 7200 grains, its ounce = 451 grains, or at Tower standard 450 grains, was the greater rotl. Or its ounce was 9 dirhems of that rotl, dirhems of 50·03 grains.

It is thus seen that every European pound is composed of ounces on a dirhem-basis, of 8, 9, 10 or 12 dirhems; or, as in the case of the averdepois ounce,

coinciding with the ounce of 6 mithkals or 9 dirhems. The ounce was—

8 dirhems in the light Mediterranean pounds.
9 dirhems in the medium pounds of Spain and Cologne.
10 dirhems in the Troy pounds.
10 greater dirhems in the Russian pound.
12 drachmæ in the Venetian pound.

Original Weights of the Dirhems

1. Coin-weights :—			Grains.
	Aureus, $\frac{1}{6}$ of As-ounce		70·1
$\frac{3}{4}$	,, $\frac{1}{8}$,, ,,	greater dirhem	52·6
	Mithkal, $\frac{1}{6}$ of Egypto-Roman ounce		72·74
$\frac{3}{4}$	,, $\frac{1}{9}$,, ,, ,,	lesser dirhem	48·5
2. Rotl-weights :—			
$\frac{1}{100}$ lesser rotl		drachma	57·63
$\frac{1}{144}$ greater rotl		medium dirhem	50·03

CHAPTER XIX

FOREIGN MEASURES OF CAPACITY

1. The Teutonic System

Measures of capacity are always either—

(*a*) based on a certain cubed linear measure;

(*b*) made to hold a certain weight of water or of corn.

A measure of capacity for wine or other fluids may be increased in water-wheat, or pound-pint, ratio to make a corn-measure.

In England they were originally based on the measure of 1000 ounces of water, which became a cubic foot. Many foreign measures are either a cubic foot, sometimes increased in water-wheat ratio, or a cubed cubit.

In Germany, amid a great diversity of measures, a chaos to anyone who has not the key to the principle of unity underlying variety, apparently aberrant measures often show by their names that, while their value has changed, they were originally of a standard that can be traced. And it will generally be found that they are related to a cubic foot, perhaps increased in water-wheat ratio. Sometimes there is one measure for wine and corn, and sometimes the increased corn-

measure may have come to be used for fluids while the corn-measure actually in use has been imported.

Taking three representative German feet, and evolving from them their cubic measure, we have:

	Foot.	Cubic foot.	Gallons.	× 1·25
(*a*) Amsterdam	11·146 in.	1384·6 c.in.	= (4·94)	= 6·15
(*b*) Hamburg	11·241 ,,	1420 ,,	= (5·12)	= 6·4
(*c*) Rhineland	12·356 ,,	1886 ,,	= 6·78	= 8·5

(*a*) In Holland there seems to be no measure of capacity corresponding to the cubic foot, but this, increased in w.w. ratio, gives the Schepel = 6·12 gallons, the Skipple of New England.

(*b*) In Hamburg the cubic-foot measure is also absent, but the w.w. increased measure appears as the Eimer = 6·375 gallons, now used for wine, and this measure, again increased, appears as the Anker = 7·97 gallons, both being now fluid measures.

In Bremen and Lubeck, the Eimer = 6·4 gallons, and the Anker = 8 gallons, the one of 4 and the other of 5 viertels, are both wine-measures; while the corn-measure, the Scheffel, = 7·6 gallons, is very nearly the old English corn-bushel.

(*c*) Prussia and Hanover both had the Rhineland foot, but Prussia, while recognising the cubic foot of water as 66 lb. weight, Cologne standard, had no corresponding measure of capacity. In Hanover and in Brunswick the Rhineland cubic foot of water, = 6·78 gallons, was represented, not by a wine-measure, but by a corn-measure, the Himt = 6·852 gallons. And the increased measure, 6·85 × 1·25 = 8·56 gallons, which should properly have been the corn-

bushel, appears in Hanover as the Anker, a second wine-measure.

And yet a wine-measure corresponding to the Rhineland cubic foot did exist, in the Viertel = 1·713 gallons, exactly one-fourth of the capacity of the Himt. Five viertels make an Anker, which shows that the Himt, presumably at first a wine-measure of 4 viertels or quarters, was increased in water-wheat ratio to the Anker of 5 viertels. But their original positions were reversed: the Himt became a corn-measure and the Anker a wine-measure.

The original wine-measure of 4 viertels, now the Himt corn-measure (represented in Scotland by the Firlot), is important in this story.

The existence of the Himt supports my hypothesis of the origin of the Rhineland foot. The side of a Himt of quadrantal, or exactly cubical, shape measures 12·385 inches, not $\frac{3}{100}$ of an inch above the 12·356 inches of the Rhineland standard foot.

The Himt is then the Troy talent of 1000 ounces, $\frac{2}{3}$ of the Arabic kantar, which was 1500 Troy ounces, in just the same way that the English wine-bushel = a cubic foot, the measure of 1000 old averdepois ounces of water, was $\frac{2}{3}$ of the Alexandrian talent of 1500 Egypto-Roman ounces.

The Himt being the Troy talent-measure, $\frac{2}{3}$ of the Arabic cubic foot, it should have to the Arabic cubic cubit a proportion $\frac{2}{3}$ of the normal proportion $\frac{1}{3{\cdot}375}$ of any cubic foot to its cubic cubit. So the Himt = 6·852 gallons $\times \frac{3}{2} \times 3{\cdot}375 = 34{\cdot}688$ gallons, almost

exactly the Arabic cubic cubit, which became the Cargo of Marseilles, or the Setier of Paris. Now this standard of 34·73 gallons or thereabouts is not uncommon in Germany. In Hanover and Hesse-Cassel the Ohm = 34·26 gallons is a wine-measure, in Saxony the Malter = 34·7 gallons is a corn-measure, divided into 12 scheffels. Corresponding to this in England was an ancient measure, the Amber (Hamberboune, Hamberbarrel). In other parts of Germany where the cubic foot is smaller, being derived, as in Hamburg, from a foot = 11·24 inches (or at least corresponding to this foot), the cubic foot there gives a measure = 5·12 gallons, and when increased in w.w. ratio = 6·4 gallons. This latter measure × 5 gives 32 gallons, and this number of gallons, either as an Ohm, wine-measure, or × 8 = 32 bushels as a Malter, or corn-measure, is common throughout Germany. There seems in many places to have been a double standard, the smaller derived from a cubic foot, and the larger derived from the Arabic cubic cubit and somewhat cut down to become a multiple of the smaller measure.

The Viertel, = 1·713 gallons, the quarter of the Himt, is also an important measure, not only as giving the clue to the Troy talent, but also as a very widespread wine-measure.

It passed to France, there becoming the Velte = 1·62 gallons at Bordeaux, 1·76 gallons at Paris, where its introduction into the series of wine-measures broke the regular division of the Muid. At Bordeaux this velte was probably the cause of the English wine-gallon increasing from its original 216 cubic inches ($\frac{1}{8}$ of the

cubic foot, or wine-bushel of 1000 ounces) to 231 cubic inches. At the latter capacity it became just half of the Bordeaux velte.

The shrinkage of the Bordeaux velte to 1·62 gallons may have been the effect of adaptation to an English double wine-gallon, or it may have been from the velte, when passing to Holland, having to adapt itself to the other wine-measures of that country. The Dutch Velt or Welt took a place between the Stoop, = 0·5337 gallons, and the Steekan, of 8 stoopen; and it thus became a measure of 3 stoopen = 1·601 gallon.

It gave rise to the Legger, of 80 velts. This passed to English trade as the Leaguer, but failed to establish itself, being soon only known as a long cask of about 150 wine-gallons used for the lower tier of water-casks in ships. Above the 'leaguers' came the 'riders.'

The Velt and the Leggar are still used in colonies now or formerly Dutch. The Leggar in Java = 127·34 gallons.

The Velt = 1·6 gallons at the Cape & Java (approximately).
,, ,, = 1·63 ,, ,, Mauritius.
,, ,, = 1·66 ,, ,, Ceylon.
(,, ,, = 1·67 ,, in France, near La Rochelle.)

But the Viertel maintained, even increased, its standard of 1·713 gallons when entering the Marseilles-Paris systems of wine-measures as the Velte; rising to 1·77 gallons in order to become half of the Escandau of Marseilles, and taking a place at = 1·76 gallons in the Paris series of wine-measures (see

Chapter XXI). Coming from the North, it was yet an evolution of the Arabic foot, while the Escandau was $\frac{1}{8}$ of the Marseilles Cargo reduced in wheat-water ratio, and this cargo was the Arabic cubic cubit.

2. The Mediterranean System

The Moslem conquest of the greater part of the Mediterranean countries, with the influence of Arab trade and of Moorish civilisation, displaced the Roman system of weights and measures, already modified by the influence of Ptolemaïc Egypt, and caused changes even in the weights and measures of Italy. Not only the North of Africa, but Spain, Provence (and the other Occitanian lands), the dominions of the three republics of Venice, Genoa and Arles, with the countries forming the Turkish Empire, all these took more or less the Arab system of weights and measures, and this system penetrated deep into Western Europe.

The principal Arab measures which form the basis of the Mediterranean measures of capacity were :

1. The cubed Persian cubit = 8 Persian cubic feet (the Persian foot being half the cubit of 25·26 inches). The Persian cubic foot of water being the Persian or Greek-Asiatic talent, at its calculated value of 72·61 lb., the cubed cubit is $8 \times 72{\cdot}61 = 580{\cdot}88$ lb. = 58·088 gallons.

This was the Arab (and Hebrew) Den = 58·2 gallons, divided into

4 Artaba of	14·55	gallons
each of 4 Wuebe of	3·6375	,,
each of 6 Saa of	0·6064	,,

The Artaba was thus = 2 cubic feet, and the Saa was the qirât, $\frac{1}{24}$ of the Artaba.

The modern Persian Artaba = 14·47 gallons.

2. The cubed Black cubit of Al-Mamūn = 34·73 gallons.

3. The cubed Black foot of Al-Mamūn = 10·29 gallons, the weight of which was the Kantar = 102·92 lb.

4. The Ardeb = 4 cubed Black feet; 4 × 10·29 = 41·168 gallons.

The measures derived from these cubed linear measures are as follows:

1. The first of these measures, the cubed Persian cubit, has been accurately preserved in the Cafiz of Tunis, which is the Den, doubled, 2 × 58·088 = 116·4 gallons. Its present standard is 116·34 gallons, and it is divided into

16 Wuebe of 7·27 gallons ($\frac{1}{2}$ Artaba)
each of 12 Saa of 0·605 „

While the Cafiz of Tunis is of 8 Artaba, the Cahiz of Spain is of 10 Artaba, 10 × 14·55 = 145·5 gallons. It is divided into

12 Fanegas of 12·125 gallons
each of 12 Almudas or Celemines of 1·0104 gallons.

The present standard in Spain of the Cahiz = 144·7 gallons, the Fanega being = 12·06 gallons, and the Celemin = 1·005 gallon. The Tomolo of Naples is = 12·22 gallons.

2. The second measure, the cubed Black cubit = 34·73 gallons, is the basis of the fluid (oil and wine) measures of Tunis, and also of Spain, Provence and Paris.

Reduced in inverse water-wheat ratio, it gives $\frac{34 \cdot 73}{1 \cdot 22}$ $= 28 \cdot 46$ gallons.

This fluid measure, apparently not extant at the present time, is yet found in its double, the Moyo of Spain = 56·79 gallons, and its half, the Mezzaruola of Italy, the Mieirolo of Marseilles.

The Mieirolo is the basis of other important measures; its standard, $= \frac{28 \cdot 46}{2} = 14 \cdot 19$ gallons, is found—

in Tunis =13·97 gallons
in Tripoli =14·19 ,,
in Spain =14·23 ,, (¼ Moyo).

A quarter of this measure is the *Arroba mayor* of Spain (arroba = al-rūbá, the fourth), the Escandau of Marseilles = 3·54 gallons.

The half of the Arroba, or of the Escandau, corresponds to the Velte, 1·76 gallon at Paris, 1·73 gallon in Hanover, &c. It is the meeting point of Northern and Southern measures, which are derived quite separately from Al-Mamūn's cubit, the former by weight, the latter by measure.

The measures of Portugal differ little from those of Spain. The corn-unit is the Fanga (Sp. *fanega,* Ar. *faníqa,* sack) = 12·17 gallons. There appears to have been a larger unit of 6 fangas, as the name of the Alqueire, ¼ fanga, implies that this smaller unit was a qirát, $\frac{1}{24}$ of a large measure = 6 fangas.

The alqueire varies in capacity. In Brazil it is our Imperial bushel.

In Spain the fanega is the usual seed-measure of land; it is = 1·6 acre (exactly the saumado seed-measure of Provence), though probably that amount of land requires fully 2 fanegas of seed-corn.

The cubed Black cubit appears also as a corn-measure, its original purpose.

Original standard 34·73 gallons	= 4·34 bushels
Rebekeh of Egypt	= 4·32 ,,
Cargo of Marseilles	= 4·26 ,,
Setier of Paris	= 4·29 ,,

3. The cubed Black foot, = 10·292 gallons, passed with the Moors to Spain; it was the standard of the old Burgos fanega until the fifteenth century, when the present Avila standard prevailed.

4. The Ardeb of 4 cubed Black feet, 4 × 10·292 = 41·168 gallons, is represented by the Cairo Ardeb of the present time, = 40 gallons or 5 bushels, generally somewhat more. It is divided into 6 Wuebe, each of 4 Rūba or quarters, which are qiráts, $\frac{1}{24}$ of the Ardeb. The standard of the Cairo Ardeb varies. It is sometimes put at as much as 5·44 bushels = 43·52 gallons. The official standard of the Ardeb of wheat is 297 lb., = 38·5 gallons at 60 lb. to the bushel.

Turkey

The weights and measures of capacity seem a maze of confusion, until the clue is found. There is a double series of weights based on the dirhem and on the ounce. This ounce is not mentioned in the series of weights, but once discovered, it gives the clue to the maze, and the system is then seen to be really simple.

It has already been seen that the weights are in a double series giving the Oka of 400 dirhems, and the Cantar of 2000 Egypto-Roman ounces, = 124·7 lb., divided into 100 rottoli. The weight of the dirhem, = 49·5 grains in the cheké goldsmith's weight, becomes = 49·6 in the Oka, $\frac{1}{44}$ of the Cantar.

Fluid-measure.—A double cantar, 2 × 124·7 lb. = 249·4 lb., was increased in water-wheat ratio, 249·4 × 1·25 = 311·75 lb. = 31·175 gallons. The actual capacity of this water-Cantar is 31·412 gallons. This measure is divided into 100 rottoli-measure (= 3·14 lb. of water), each of 2½ rottoli weight = 50 ounces.

Corn-measure.—The Cantar measure becomes, for corn, the Fortin, at a standard of 31·1 gallons. This measure being 2 × 1·25 = 2½ times the Cantar weight of 2000 ounces, contains 5000 ounces of water or 4000 ounces of wheat. It is divided into 4 Killows of 7·775 gallons. This measure is evidently named from the Greek *chilioi* (Fr. kilo) as holding 1000 ounces of wheat. It is divided again into 4 Saa.

The Fortin is also divided into 88 rottoli, the rottolo containing 500 dirhems of water or 400 dirhems of corn.

In fluid-measure there is an oka-measure ; 8 oka, = 3⅔ rottoli-measure, make an Almud = 1·15 gallon. I only mention this intrusive measure to confer it with the Spanish Almuda or Celemin = 1·01 gallon.

These Turkish measures, fluid and corn, afford another instance of the practice of increasing a fluid measure in water-wheat ratio, and then of using this

increased measure for fluids as well as corn. Instances of this practice have been seen in German measures (for instance the Himt). And our own gallon affords a somewhat similar instance. Increased from the cubic foot to make a corn-gallon, this was again increased by 3 per cent. to make the Imperial gallon, both for fluids and for corn.

Italy

The system of measures left from ancient Rome, themselves of Oriental origin, has been to a great extent overlaid by Arabic measures.

In Bologne the Corba, = 17·3 gallons, is half the cubed Black cubit, to which the Neapolitan oil-Salma, = 35·5 gallons, is closely approximate.

In Rome the principal corn-measure, the Rubbio = 64·77 gallons, bears an Arabic name; it is doubled in the Tuscan Moggio, and investigation would probably discover a measure of 4 rubbii = 259 gallons = $32\frac{1}{3}$ bushels or about the old English chaldron of 4 quarters.

The Starello of Sardinia, = 10·8 gallons, is approximately a quarter of the Ardeb.

3. Hebrew Weights and Measures of Capacity

The Hebrews used the measures of Egypt and Phœnicia. The common Egyptian cubit, very near 'the cubit of a man,' was the usual measure of length. They brought back from the Captivity some Persian measures:

1. The Great Assyrian cubit, which is 'the cubit and an hand-breadth.'

2. A measuring Reed of six cubits long, by the cubit and an hand-breadth = the modern qasáb of Egypt.

3. The Cubit of the Talmud = 21·914 inches, the $\frac{1}{8000}$ of the Bereh, which was $\frac{1}{1000}$ of an hour on the equator (see page 27).

For weights they used the Alexandrian talent or Kikkar divided in the Phœnician manner into 50 minás of 60 shekels = 218½ grains. This shekel was sometimes called the Shekel of the Sanctuary and was then divided, not into 8 Gerahs of 27·31 grains (our dram, $\frac{1}{16}$ of the Egypto-Roman ounce) but into 2 Bekah or 4 Reba or 20 Gerah = 10·9 grains. The Reba, ¼ Shekel, was the drachma of the Phœnician weights, = 54·62 grains.

When, as recorded in Exodus xxvii, 603,550 men contribute each a Bekah or half-shekel of silver, the amount of 301,775 shekels is stated to be = 100 talents and 1775 shekels, after the shekel of the Sanctuary. In this statement the talent is of 3000 shekels, according to the Phœnician reckoning.

In Ezekiel xlvi, the shekel is given as of 20 gerahs and the miná is stated to be 20 + 25 + 15 = 60 shekels, confirming the Phœnician mode of dividing the Alexandrian talent as that used by the Hebrews, viz. 50 minás of 60 shekels.

The measures of capacity had for principal unit the Olympic talent, the weight of water of the common Egyptian foot cubed, = 6·48 gallons. It was called

the Bath for fluid measure, the Epha for corn and other dry measure. The Bath was divided into 6 Hin = 1·08 gallon (this being about the same capacity as the Spanish and Turkish almuda) and into 72 Log, = $\frac{2}{3}$ pint. The Epha was likewise of 72 log, and 4 log made a Cab.

The Cor or Homer was a measure of 10 Epha or Bath, = 64·8 gallons or 8·1 bushels. It coincided approximately with 2 great Artaba, this measure being the cubed Royal cubit = 31·695 gallons ; × 2 = 63·39 gallons.

The Hebrew field-units were at first seed-measures, afterwards fixed geometrically.

The unit was the Bathsea, sown with a Bath of grain ; it was 8 qasáb, or 48 great cubits, square, = a rood.

The Betheoron, sown with a Cor, 10 Bath, of grain, was 10 of the lesser unit and therefore = $2\frac{1}{2}$ acres.

In these three chapters on foreign measures and weights I have tried to show the principles of unity underlying the variety of measures. To describe them fully would require a series of monographs which, however interesting, would lack the more important general view. I shall therefore confine myself to the full description, in Chapters XXI and XXII, of the measures and weights of France which, both in the old system and in the metric system, are of special interest to us. Before proceeding to these I must treat, in a somewhat discursive chapter, of the meanings of some names of measures.

CHAPTER XX

THE DEVELOPMENT OF MEANING IN THE NAMES OF WEIGHTS AND MEASURES

1. General Remarks

In the various names of weights and measures there are many general-utility words which offer no difficulty in the sphere of those who use them habitually, yet which are sometimes puzzling to others, while they are interesting to the student of semantics. They form a chapter in the history of weights and measures, itself a volume in the history of the human mind.

Some terms have an obvious meaning, as 'half' and 'quarter.'

These inevitably run through the usual series of measures. Even the metric system has to tolerate half-units as a concession to unscientific weakness while refusing quarters otherwise than as 25 hundredths of the unit. But quarters are firmly rooted in the human mind and resist scientific attempt to extirpate them. They are very common in the sexdecimal series, representing a fourth of one unit and four of a lower unit.

Quart and Quartern have acquired certain definite senses, the first of a quarter-gallon, the second either of a quarter-pint or of a quarter-peck. Quarter by itself is of wide application; it may mean the fourth of a pound or of a hundredweight or of a dollar, or of an acre. In its Teutonic form we have it in farthing and in firkin. France has its *quart* as a quarter-pound, its *quartié* in land-measure, its *quarteron* as a quarter-hundred, though usually 26.

The context, whether in writing or in speech, usually shows the meaning of 'quarter' unless that meaning has been destroyed by legislation, as in the case of the Quarter of wheat where the meaning of the word could not be recognised either by the eminent scientific member of a Parliamentary Committee or by the scientific expert in measures giving evidence before him. The Quarter has remained, while the Chaldron, of which it was a fourth, was so worried by legislative interference that it disappeared as a corn-measure.

The French Setier in its different senses of a load of corn, of a bushel, of a double gallon, and of a pint, had long lost all connection with L. *sextuarius*; it had indeed got to mean a quarter in the same way that in Italy the *sestiero*, originally one of the six districts of a city, had acquired a similar sense to the French *quartier* as a district. The French setier or sestié had so lost its original meaning as to be often written 'septier,' as if it were a seventh.

The Greek obolos (originally meaning a copper nail), $\frac{1}{6}$ of a drachm, acquired in Latin the sense of 'half.' When the drachma took the weight-sense of 60 grains,

an obolus was 10 grains; but this was half a scruple, so it took a general sense of 'half,' and the halfpenny was latinised as an obolus.

Maille was the corresponding French word for halfpenny, being It. *medaglio*, Prov. *medaio*, akin not only to 'medal' but also to 'metal,' in which there seems to be a sense of 'half' of an alloy. Yet it became a weight of $\frac{1}{4}$ ounce, perhaps from being half of the loth or half-ounce. And the Fr. *felin*, It. *ferlino*, probably corruptions of vierling or farthing, on becoming $\frac{1}{4}$ of the *maille*, was $\frac{1}{16}$ of the ounce. In the section on terms used in old land-measures I have shown the equivocal sense of words related to 'ferling.'

Our Yard, from the influence of its French equivalents—*verge*, rod, and *vergée*, rood—became a quarter-acre, and then a quarter-hide.

The Drachm as a part of the Troy ounce, $\frac{1}{8}$, became the dram as a part of the averdepois ounce, $\frac{1}{16}$. As a measure it became $\frac{1}{8}$ of a spirit pint.

The terms signifying $\frac{1}{12}$, $\frac{1}{16}$, $\frac{1}{24}$ and some smaller fractions of weights or measures, show a development of meaning which will be given in the following sections.

2. The Nail and the Clove; the Inch and the Ounce

The yard is lawfully divided (as was also the ell) into 4 quarters and 16 nails.

The hundredweight is divided into 4 quarters, 8 stones and 16 cloves or nails.

How did 'Nail' come to mean a sixteenth of a unit, length or weight?

The 'New English Dictionary' throws no light on the origin of this peculiarly English term. The only other general name I know for a sixteenth is the Indian 'anna,' the sixteenth of a rupee, of a crop, of a venture, &c.

The story of the Nail reaches back to the early history of weights and measures and is of philological as well as metrological interest. The half-cubit or span, the common handy measure in most parts of the world, is of 12 digits, while the foot is 16 digits and is still so divided in Italy and other southern countries. The digit is not only a middle-finger breadth, it is also a thumb-nail breadth; as the former it was in Greek *dactylos*, as the latter *onyx*, which became *onkia* in Southern Italy and gave rise to two Latin words, *unguis* for the actual finger-nail, *uncia* for the thumb-nail breadth equal to the digit and generally for a twelfth part. Hence a differentiation of meaning in the Romance languages.

GREEK *onyx*, *onkia*

Latin	*unguis*	.*uncia*, thumb-nail breadth, ounce
Italian	*unghia*	.*oncia*, last thumb-joint, ounce
Provençal	*ounglo*	..*ounço*, finger-joint, knuckle, ounce
French	*ongle*	..*once*, finger-joint (obs.), ounce
English	(nail)	..*unce*, ynch

When the Romans adopted the duodecimal or 'uncial' system they applied it to the foot, which was divided into either 12 or 16 parts both called unciæ;

but to distinguish these they used two other words, *digitus* for the sixteenth and *pollex*, thumb, for the twelfth, the thumb-breadth.

In English 'unce, ynch' always meant the thumb-breadth $\frac{1}{12}$ of a foot, 'Nail,' the thumb-nail breadth equal to the digit, being kept for the $\frac{1}{16}$ foot. Thence 'nail' came to have the general sense of sixteenth and to be applied to that fraction of a 4-span yard, of a 5-span ell, of a bushel, of a hundredweight.

In Latin the analogous general sense of twelfth belonged to *uncia*, whether of the foot, of the land-unit, of the pound. The general sense of twenty-fourth attached to the scruple as $\frac{1}{24}$ ounce, passed to the qirát, or carat, in the countries influenced by Arab customs, as being $\frac{1}{24}$ of the mithkal, the Arab successor of the Roman solidus.

In modern Italy the palmo or span, and the libbra or pound, were both divided into 12 *oncie*, meaning inches or ounces.

With the general substitution of the 16-ounce pound for that of 12 ounces, the word 'ounce' lost its meaning of twelfth. In some of the Romance languages its sense of length extended to the length of any finger-joint, especially to the length of the proximal joint of the thumb. Thus in Southern France the *ounço dóu pouce* (Fr. *once de poulce*) was taken as $\frac{1}{5}$ of the span or nearly 2 inches.

When our Cwt. was raised to 112 lb. and the 16-lb. stone replaced by that of 14 lb. the term Nail was applied to the half of the new stone, and it was perhaps the divisibility of the new Cwt. into 16 parts of

7 lb. that reconciled people to the unpopular new weight. But for all that, the people held on for centuries to the 16-lb. stone, and call its half, 8 lb., a nail, though it is no longer the sixteenth of a larger unit.

When the half of the 14-lb. stone was legally called a nail, how was this term to be rendered into law-Latin or statute French by the scribes of Plantagenet times ignorant of the origin of the term? Naturally they blundered; they got hold of the wrong nail, rendering it by L. *clavus* instead of by *unguis*, and by Fr. *clou*, *cloue*, or in the script of the time *clove* instead of by *ongle*. This misnomer took; and a statute of 1430 states that a Wey of cheese may contain 32 cloves, every clove 7 lb., making the wey = 224 lb., 2 Cwt. But despite statutes the cheese-trade went on with its 8-lb. clove, of which 32 make 256 lb., the true wey.

It was the same with the wool-trade, controlled by the State for revenue purposes. The half-stone of wool became a nail. In 1342 we find *quatuor clavos lanæ*, 4 nails of wool.

But *clavus*, a nail, became confounded with *clavis*, a key, and so in Southern France the nail-weight, introduced from England, became *clau*, a key, instead of *clavèu*, a nail. Thus the nail, Fr. *once*, *ongle*, became clove, Fr. *clou*, L. *clavis*, an iron nail; then in Prov. and Fr. *clau*, L. *clavus*, a key.

3. The Carat and the Grain

(a) *The Carat*

One would hardly recognise the golden Solidus of

Rome in the French Sol, the brass halfpenny with the effigy of Louis XVI, current within my memory, or in the bronze Sou by which sums under three francs are still reckoned in France.

The Solidus, Aureus, or Exagium solidi, was so called because, representing the As, or unit of money, it was the gold-unit of which the semissis was the half and the tremissis the third.

Weighing 70·1 grains (under Constantine) it was $\frac{1}{6}$ of the Roman mint-ounce = 420$\frac{2}{3}$ grains, or $\frac{1}{72}$ of the As libralis. Its weight was equal to 24 siliquæ, afterwards called Carats = 2·921 grains, and its third, the tremissis, weighed nearly 24 grains, the troy pennyweight. Hence pure gold was considered as solidus or 'entire' of 24 carats, and the quality or 'touch' of gold would be denoted by the number of carats of pure gold it contained out of 24. The carat of fineness was divided into 4 assay-grains, and these again into fourths. English gold coins are 22 carats fine since the time of Henry VIII, but the Plantagenet gold coins were usually 23 carats 3$\frac{1}{2}$ grains fine, that is $\frac{191}{192}$ = nearly 995 in 1000.

Thus the carat was $\frac{1}{24}$ Solidus or $\frac{1}{144}$ ounce.

When the Arab caliphs had conquered Egypt and the greater part of the Mediterranean countries, they followed Roman imperial customs and replaced the gold Exagium solidi, $\frac{1}{72}$ of the As, by the gold mithkal, $\frac{1}{72}$ of the Libra or Egypto-Roman pound. The Mithkal was then $\frac{1}{6}$ of the Egypto-Roman ounce = 437 grains, so that it weighed 72·7 grains. It was divided like the Roman coin into 24 qirât, each = 3·035 grains and

divided into 4 hubba or light grains, meaning corn-grains.

The Ptolemaïc or lesser Alexandrian talent had been divided into 60 minás of 12 ounces; these either 100 drachmæ or 12 × 12 carats of 3·1616 grains. The carat was an ancient Eastern weight, originally the flat seed of the caroub or locust-tree, *Ceratonia siliqua,* and in Greek *keration.* Throughout North Africa and in other Moslem countries there are two usual lesser units of weight:

The Mithkal = 72·7 grs. of 24 Kharūb or qirát
The Dirhem = 48½ ,, ,, 16 ,, ,, ,,

The carat, from a goldsmith's assay-weight, became the unit for the weight of precious stones, varying slightly in different countries and usually divided into 4 diamond-carats.

THE CARATS

Roman siliqua	2·916	grs. ¼	= ·729 gr.
Roman-Egyptian carat	3·035	,, ,,	= ·758 ,,
Ptolemaïc ,,	3·1616	,, ,,	= ·790 ,
Venetian ,,	3·196	,, ,,	= ·799 ,
Egyptian (modern) ,,	3·088	,, ,,	= ·772 ,
Spanish (Moorish) ,,	3·082	,, ,,	= ·770 ,,
Amsterdam (diamond) carat	3·165	,,	
Hamburg ,, ,,	3·176	,,	= $\frac{1}{142}$ Cologne oz.
English ,, ,,	3·177	,,	
French metric ,,	3·086	,,	= ·2 gramme

The Eastern qirát has retained all the derived senses seen in the Western carat, $\frac{1}{24}$ of a pure gold-unit.

A cubit of 28 digits has an alternative division into 24 qirát. The kharūb of Egypt, 16 to a dirhem and 24 to a mithkal, is the weight-counterpart of the digit, 16 to the foot and 24 to the cubit. The density of brine is on a scale of 24 qirát. Points in a competition, shares in a business or ship are reckoned similarly. At Marseilles the ownership of a vessel is divided into 24 qirát as it is in England into sixty-fourths.

'Ai un queirat sus un navire': *Calendau* v. (by Mistral).

Sometimes the 24 qirát are grouped into 4 *rob* of 6 qirát. *Rob* is from Ar. *al rabaa*, fourth; cf. *rubaiyat* = quatrain. In Spain and Portugal the arroba, in Provence the *rub* (It. *rubbio*) is the quarter-hundredweight.

The Refiner's Carat

There is another use of the term Carat, confined to goldsmiths and refiners of the precious metals. The old troy pound was regarded as 24 carats; the carat was 4 grains, each of 4 quarters or of 60 grains. This system was used in the refinery of the Royal Mint up to 1882.

In Germany the Cologne marc (8 ounces) was divided by refiners (1) for gold into 24 carats of 12 grains; (2) for silver into 16 loth (half-ounces) of 18 grains.

It is probable that this system came to England with the Tower pound (12 ounces of the Cologne marc) and was continued with the Troy pound.

(B) *The Grain*

The names given to the smaller weights were taken from seeds just as measures of length were named after limb-lengths corresponding roughly to them. The kharoub may be used for a carat-weight. The ruttee or ráti, a scarlet pea with a black spot, is used in India as a goldsmith's weight = 1·75 grain. Poppy-seeds, mustard-seeds, barley-corns, wheat-corns, have been used for minute weights. The Grain was the Greek *sitatrion*, a wheat-corn. It was perhaps from the custom of saying that 3 poppy-seeds = one mustard-seed, and that 6 of these = one barley-corn, &c., that an idea arose of these seeds being the basis of systems of weight. It has been seen that the definition of the Plantagenet mint-weight was that 32 wheat-corns were the pennyweight. This idea, hallowed in our statutes, is not yet extinct.

Ambroise Paré, in treating of medicinal weights (1582) said :

> Every weight arises from some beginning and element. For as our bodies arise from the four first simple or elementary bodies, so all weights arise from the grain, which is *tanquam* the beginning and the end of the remainder. We understand a grain of barley, neither dried nor mouldy, but well made and of medium fatness. From 10 grains of this sort comes the obolus, from 2 oboli or 20 grains the scruple . . . &c.

This is medieval rubbish. As John Greaves, Professor of Astronomy at Oxford, in his 'Discourse of the Roman foot' (1647) wisely said :

> I cannot but approve the counsel of Villapandus who

adviseth such as will examine measures and weights to begin with the greater and not the lesser. . . . The most curious man alive with the exactest scale that the most skilful artisan can invent, shall never be able, out of the standard of one grain, to produce a weight equal to the weight of ten thousand grains.

While the subdivision of linear measures and of weights usually stopped at some familiar quantity named after a seed, yet efforts were sometimes made to get at an ultimate atom as the term of the series. The Hindus who began, or ended, a series of weights with one of the motes or fine particles of dust visible in a sunbeam, were imitated by the English moneyers who continued the 20-dwt. and 24-grain series by dividing the grains into 20 Mites, each of 24 Droits, each of 20 Periots, each of 24 Blanks, the blank being $\frac{1}{230400}$ of a grain.

So our mint expressed the weight of a Stuart silver penny, not as $7\frac{23}{31}$ grains (all the silver coins having then a fraction of 31sts); that would have been too simple—but as 7 grains, 14 mites, 20 droits, 2 periots, 12 blanks. Even then the statement was not exact; one or two more infinitesimal units would have had to be added to the series.

It may be noted that $7\frac{23}{31}$ grains is simpler than the modern decimal equivalent 7·74193548, &c.

The origin of these mint-terms is obscure; the 'N.E.D.' casts no light on it. I consider their source to be—

Mite—mijt, a small Dutch coin.

Droit—a corruption of the Dutch *duit*, Sc. 'doit,' a

fraction of a farthing. It was more properly written 'dwit'; perhaps the *r* was inserted to avoid confusion with 'dwt.'

Periot—a period or full stop; perhaps influenced by 'iota' and 'jot.'

Blank—as the blank in dominoes, still lower than the ace, point, or full stop, the Dutch As; perhaps influenced by 'point-blank,' in which the bull's eye, at first the 'point,' became the blank or white.

It has been seen, under Troy weight, that there are two classes of grains:

The heavy grain $\frac{1}{20 \times 24} = \frac{1}{480}$ ounce as in English Troy.

The light grain $\frac{1}{24 \times 24} = \frac{1}{576}$ ounce as in French Troy.

The ounce of 576 light grains was used in France, some Italian states, Spain and Portugal. Elsewhere, throughout Europe, the mint and medicinal ounce was 480 heavy grains, the scruple being 20 grains.

The heavy and light grains have been connected respectively with the barley-corn and the wheat-corn. They may have been so originally, but it is more probable that the grain, at first a seed-weight, came to mean a division of the scruple into either 20 or 24 parts.

In Dutch mint-weight the Troy ounce was of 20 dwt. or Engels, each of 2 mail, 4 vierling, 8 troisken, 16 deusken, 32 azen or aces. The Aas was the wheat-corn of our mint-legend. In the Spanish Netherlands

the Engel was increased to make the ounce 24 × 24 grains. The Engel thus became (Antwerp 1580) = 28·8 grains = $1\frac{1}{5}$ English dwt. The word Engel means 'angel,' not the angel coin weighing 3 engel 10 azen, but Angle—'Angli, non Angeli.'

4. The Tun and the Fother

These words belong to an onomatopæic class :

1. Bung—akin to 'bomb,' to Fr. *bonbonne,* a more or less globular vessel giving out a 'bom' sound when struck. In Somerset the bung-hole of a cask is the bum-hole ; a 'bun' is a puffed somewhat semi-globular cake. Bung was probably a cask ; the word is applied to a portly publican fancifully resembling one of his casks. Bumboat probably meant a boat carrying 'bums' or casks to ships.

2. Ton, tun—a large cask giving a thundering sound. L. *tonitru,* Fr. *tonnerre,* whence Fr. *tonne,* our ton for weight, tun for capacity.

3. Fr. *Foudre,* a 'thundering big' cask or vat. L. *fulgur,* Fr. *fouldre, foudre,* a thunder-bolt, in German *fuder,* whence our 'fudder' and 'fother,' about a ton of coal or of lead, a cartload of about a ton.

CHAPTER XXI

THE OLD MEASURES AND WEIGHTS OF FRANCE

UP to the time of the Revolution each province had its own measures and weights, more or less influenced by the uncertain standard measures of the king in Paris. This was the effect of the feudal system and of the very gradual annexation of the provinces under conditions which left considerable powers to the parliaments and other local authorities. Even in each province varieties of measures were to be found, and they exist to this day in each *pays*, often in each parish.

The basis of this very loose system was Roman, influenced in the North by Teutonic importations, but especially by the peculiar and intrinsically perfect system of the South, where the Roman basis had entirely disappeared under the influences of commerce with Egypt and with that portion of Africa which begins across the Pyrenees, and which in medieval times imparted much of its high civilisation to European countries.

1. THE SOUTHERN SYSTEM

This system, prevailing far beyond the limits of Occitania, the land of the Lengo d'O, had for its basis the Load of Wheat, a measure very nearly that of the

cubed Arabic cubit, and comparable with the English Coomb or half-Quarter. Just as the English Quarter of corn is 8 bushels, so the Cargo (load, or Saumado, ass-load, Seam) is 8 Eimino. And just as we had a wine-bushel, originally a cubic foot in water-wheat ratio with the corn-bushel, so Occitania had its Escandau for wine corresponding, in the Southern water-wheat ratio of 1 to 1·22, to the Eimino or Panau. The only difference in this evolution was that, while our corn-measure was increased from the wine-measure, the southern wine-measure, and other measures evolved inversely from it, were produced from the corn-measure as a basis. The word Escandau means 'standard' (like the Denerel of Guernsey), and just as the cubic measure, the quadrantal, of 1000 Roman ounces of water, is the standard of our foot and virtually of all our other measures, so the Escandau-quadrantal is the standard of the Pán and of all the other measures of Marseilles. I take the standards of Marseilles as it was the great port of trade in the South, and incidentally those of Arles, the capital of the medieval kingdom of Arles or of Burgundy, afterwards the republic of Arles. This was so considerable a seaport, connected as it was with the sea both by the Rhone and by a canal passage, the Fossæ Marianæ, through the lagoons, that at one time the Lion of Arles was a rival of its brother of St. Mark, and gave its name to the Gulf which receives the Rhone.

The process of involution by which the Pán of Marseilles was derived from the side of an Escandau of quadrantal form has been described in Chapter IV.

The Cano or fathom, = 79·24 inches, was 8 pán or spans each = 9·904 inches; the span was of 8 menut or inches, also divided into 8 parts.[1]

The basis of the Southern system, typically that of Marseilles, was then the Cargo, a corn-measure = 34·73 gallons (the equivalent of 154·79 litres, the official metric value), which was the cubic cubit of Al-Mamūn:

21·28 inches cubed = 9639 c.i. = 34·73 gallons.

Now what water or wine measure would be produced from the Cargo, decreased in wheat-water ratio?

Dividing the measure of the cargo by 1·22 we have:

$$\frac{34{\cdot}73}{1{\cdot}22} = 28{\cdot}46 \text{ gallons.}$$

A fluid measure of this capacity is not in use at Marseilles, but we find its half, almost exactly, in the Mieirolo = 14·19 gallons, a wine and oil measure used extensively in Mediterranean ports.

The word Mieirolo, in which *mié* means half, corresponds to the name of the first in an Italian series of wine-measures:

Mezzaruola, Terzaruola, Quartaruola, fractions of a 28-gallon measure now apparently obsolete.

The standard of the Mieirolo is now at—

Marseilles,	64·384 litres	= 14·19	gallons.
Tripoli,	64·386 ,,	,,	,,
Tunis,	63·347 ,,	13·97	,,
Spain,	64.55 ,,		

[1] In Provençal, the principal idiom of the Occitanian language, nouns take no plural form; so pán, cáno, &c., do not change. The Provençal words in this chapter are pronounced—páng, cánn, saomádd, eymīnn, escandáo, panáo, cárrg, miyeyròl.

One-fourth of the Mieirolo, or one-eighth of the obsolete wine-cargo, is the Escandau, equal to the Spanish arroba (a word meaning 'quarter'), and containing, at the present Marseilles standard, 16·096 litres = 3·54 gallons. To this Escandau or standard corresponds, in water-wheat ratio, the Panau = 4·34 gallons, $\frac{1}{8}$ of the Cargo = 4·34 bushels or 34·73 gallons.

The correspondence of this series of wine and corn measures, in southern water-wheat ratio, is perfect, even after many centuries, probably since the tenth century. The Escandau and the Panau or Eimino correspond then to about 4 wine-gallons and 4 corn-gallons.

The Escandau has always been understood to be a cubic pán. Escandau[1] means a standard; Pán means a side, pane or panel, and it is the measure of the side of a 'quadrantal' containing an Escandau of water, as our foot is the measure of one containing an English talent of 1000 Roman ounces of water. The cube root of 16·096 litres is 25·24 centimetres, a length differing by less than a millimetre from the standard of the Marseilles pán = 25·16 centimetres or 9·9 inches.

Land-measures

The ancient system of seed-measures, fixed geometrically, survives to this day in Southern France, indeed throughout most of France. I shall make no apology for dwelling on it, for the linear land and

[1] Escandau is to gauge, to sound depths, to standardise. This word is from the same root as 'scandalise' applied to moral tripping, and then to the use of the 'stiliard,' the lever-balance that trips with any inequality of weight.

cubic measures of Southern France show a perfectly concordant system of measures, more so even than those of England ; indeed they are the type of a perfect system.

The largest unit of land is the Saumado, of 4 Sesteirado, each of 2 Eiminado ; these being originally the ground that could be sown with a Saumado (or Cargo), with a Sestié, with an Eimino, of wheat.

These seed-measures of land corresponding to our Coomb, Bushel and Peck land, became fixed respectively at 1600, at 400, and at 200 square cano or fathoms.

To the Sestié and the Sesteirado correspond the *boisseau* and *boisselée* of Poitou and other provinces, the *boisselée*, or bushel-land, being 400 square toises.

But the surveyor's measuring-rod is the Destre, a double cano, of 16 pán = 13 ft. 2½ in. In Languedoc, west of the Rhone, the square destre = 4 square cano is the smallest unit, so that the Saumado of land is 1600 square cano or 400 destre. But in Provence the destre of land is 2 square cano, so that the Saumado is 1600 square cano or 800 destre ; the reason probably being that the destre should be 2 cano superficial as it is 2 cano linear, and also that the Eiminado or peck-seedlip of land should be 100 destre.

The Eiminado is divided into quarters and sixteenths, corresponding to the gallon and quart divisions of the Eimino or peck. It is also divided into 20 Cosso, the ground corresponding to a cosso (= quart, wine-measure) of seed.

It is interesting to observe that the Saumado of 4 Sesteirado of 40 Cosso, corresponds, in division, to

our Acre of 4 roods, of 40 square rods.[1] And the Cosso = $\frac{1}{100}$ acre or $\frac{1}{10}$ sq. chain.

N.B.—1000 sq. cano = 1 acre.

The Saumado, of 1600 sq. cano = 1·6 acre.

Such is the typical system of Southern measures, best preserved in the neighbourhood of Marseilles, but prevailing throughout the Southern half of France, though with local variations in the length of the cano and the names of the land-units.

Measures of Capacity

These have mostly been given in the story of the pán and in the seed-measures corresponding to the land-measures.

Throughout the system the divisions in each series are sexdecimal, even the Cosso, $\frac{1}{20}$ Eiminado, being $\frac{1}{160}$ Saumado.

Weights

There were three types of pounds in South France, local variations from these being very slight. The pound was always 16 ounces, each of 8 ternau. The Ternau, so called from its being divided into 3 pennyweights, was the Arab dirhem. The three types of pound were :

Languedoc	lb.=6400 grs.	Ounce=400 grs.	Ternau=50 grs.
Gascony	,, =6280 ,,	,, =392 ,,	,, =49 ,,
Provence	,, =6030 ,,	,, =377 ,,	,, =47 ,,

(See Chapter XVIII.)

The Quintal was 100 of these pounds, but long hundredweights were common. Its quarter was the

[1] The cosso is a wooden bowl, Sc. 'luggie,' used by shepherds. Our rod is in some districts a 'lug.'

Rub (Ar. *rouba,* four). These weights are nearly obsolete, as the possession of any weights not of the Republican system would be illegal. The measures of length and capacity are often slightly altered so as to be in metric units: the pán becomes a quarter-metre; groceries are often ticketed by the hecto-gramme, as this is known to coincide very closely with the old Southern quarter-pound.

We now pass to the Northern or Paris system, mostly taken from the South, and bearing evident traces of this origin.

2. The Northern System

Measures of Length

The Roman foot survived in North France as the quarter of the Aune or ell, a measure = 46·77 inches. (Cf. the passetto or double braccio of Tuscany, of 4 palmi = 45·96 inches.) As a cloth-measure the Aune was divided, like our cloth-yard and ell, into eighths and sixteenths.

But there was also the pied de roi, the royal foot, one-sixth of the Toise, which = 76·73 inches = 1·949 metre.

The royal foot, = 12·789 inches, was divided into inches (pouces) of 12 lines, each of 12 points. Its standard was traditionally referred to Charlemagne, either to the length of his foot, or to a standard brought to him by the envoys of Harūn-al-Rashid. It coincides with half a Hashími cubit, $\frac{25·56}{2}$ = 12·78 inches.

This tradition must be dismissed; new measures are not introduced as standards in that way. It was simply one-sixth of the toise, which was a Cano from civilised South France, but its standard was so ill-kept as to be of doubtful exactitude. All that is known of its standard is that, about 1668, an iron rod was fixed in a wall of the Grand Chatelet in Paris and that the length of this rod was that of half the breadth of the eastern gateway of the Louvre-palace, which gateway was, according to the plans, 12 feet in breadth. This standard was, however, considered to be $\frac{5}{12}$ inch short of the customary toise.

The Louvre standard, taking it at = 1·965 metre (which I find it by actual measurement), corresponds closely to the Cano of Beaucaire. This town on the southern Rhone, opposite Tarascon, had a great annual fair, and may thus have given its linear standard to trade in the same way that Marseilles passed the Cargo of its Egyptian corn-trade on to Paris as the Setier, and that Troyes passed the marc used at its great annual fair on to Paris as the standard of the French troy pound.[1]

[1] There were relations between Burgundy and England. The former was, up to the fall of its powerful dukes in the sixteenth century, a state enjoying prosperity and independence, while France was mostly in a condition of misery. It had, and retained till quite recently, its system of measures and weights, derived from the southern system at the time when Arles was the capital of the kingdom of Burgundy. It had two toises, one = $7\frac{1}{2}$ French feet, the other, for field measure, = $9\frac{1}{2}$ French feet. Now the first seems to have passed to England, for a time at least, for the *Liber Albus*, 1419, contains an order for the City of London:

'The Toise of pavement to be $7\frac{1}{2}$ feet in length, and the foot of St. Paul in breadth.'

The English wool-weights, the wey, stone (12 French lb.) and clove, were current in Burgundy and in Southern France.

But the royal foot was inconveniently long for popular use, and a practice arose of taking 11 inches of it as a customary foot = 11·7 inches. This reduced foot, coinciding almost exactly with the quarter-Aune, was much used in the districts north of Paris as the *pied de Ponthieu*, or *de Clermont*. The Brasse was a short fathom of 5 pieds = 5 ft. 4 in., probably an adaptation of the Roman pace. A *pas* (pace), of half a brasse = 32 inches, is used in some districts for land-measurement.

Measures of Distance

There was no official measure of distance, such as our furlong and mile, between the toise and the league, and the league was very variable (see Chapter III). Acre-lengths, cordes, and other popular measures supplied the want, more or less well. In some districts (also in Mauritius) there were milestones at intervals of 1000 toises, called a mille. In South France the mille was divided into centenié of 100 toises or perhaps local cano. This was probably the length of the sesteirado, the rood, 100 × 4 cano.

The corde, a field-measure used before the surveyor's chain, was of variable length. In Burgundy the league of 3000 toises was divided for roadwork into 50 portées, of 12 cordes; these would thus be 5 toises or 30 feet. But there seems also to have been a corde of 33 feet, perhaps reduced feet, and thus = 30 royal feet, and this, doubled, was used as the rough measure of a 'cord' of firewood = 4 × 4 feet, in 4-foot logs. This is the probable origin of our 'cord-wood' as applied to stacked logs for fuel.

Land-measures

The units are the square toise = 4·543 sq. yards, the perche and the arpent, with other units in local usage.

There were three different perches officially recognised, and still in common use.

1. *Perche d'ordonnance* or of the *Eaux et Forêts* administration, 22 royal feet = 23·466 English feet; the square perch of 484 sq. feet = 13·44 sq. toises = 2 sq. rods.

The approximate coincidence of the quarter-aune with the reduced royal foot, i.e. of 12 Roman inches with 11 royal inches, was the probable reason of the standard perch being fixed at 22 feet = 24 Roman feet or 6 aunes.

The standard arpent was 100 square perches = 1344 sq. toises = 200 rods or 1·26 acre.

2. *Perche commune*, 20 royal feet = 21·3 English feet, the square perch of 400 sq. feet = 11·11 sq. toises = 50·47 sq. yards.

The *arpent commun* was 100 of these square perches = 1111 sq. toises = 1·04 acre.

3. *Perche de Paris*, 18 royal feet = 19·83 English feet, the square perch of 324 sq. feet = 9 sq. toises = 40·9 sq. yards.

The *arpent de Paris* was 100 of these square perches = 900 sq. toises = 0·844 acre.

The arpent commun is that of Quebec.

The arpent de Paris is that of Mauritius.

The acre de Normandie varies according to its

perch, but it is always 160 sq. perches, and if these be standard it is equal to 2 acres. But the usual unit is the vergée or rood, of 40 perches = ½ acre.

It has been seen that the Jersey vergée is 40 perches of 22 reduced English feet square, the foot being 11 inches. This is an adaptation of a very general Normandy perch, 22 feet of 11 French inches. It is = 0·44 acre.

Local French land-measures varied considerably, from different standards of perch, from different lengths taken for the foot of the perch. But the size of the unit, Journal, Estrée, &c., &c., is very generally = 1400 to 1600 square perches or roughly about 1½ acre. These measures, so irrational to the Parisian, are dear to the peasant's heart ; he understands them, and as people do not buy land as they would apples or eggs, no one is deceived.

The Estrée or Seterée (Setier seed-land) might be divided into 12 Boisselées (small-bushel lands).

Weight

The royal pound, *livre poids de marc*, the double-marc of Troyes, was one of several pounds current in Northern France. It was, like the royal foot, ascribed to Charlemagne, but his standard of weight, as known by his silver pennies, nearly always much above 24 grains, $\frac{1}{20}$ of some ounce heavier than that of the Troyes marc, was probably altered later on. The royal pound, = 5570 grains, was raised for commercial purposes (about 1350) to 16 ounces = 7554·1 grains, the ounce = 472·13 grains.

The weight of the 12-ounce pound coincides very closely with that of the Bosphoric miná, 100 drachmæ of 56·66 grains; this is perhaps the origin of the story that it was sent to Charlemagne by Harūn al Rashid. Its ounce is also approximately the Tripoli ukyé of 10 dirhems × 470¾ grains, and nearer still to 471 grains, the weight of 10 of the dirhems of which 8 made the Provençal ounce.

It is probable that the French pound was one of the lighter pounds of the variable Northern Troy series, all with an ounce of 10 dirhems of 48 grains more or less.

The ounce was divided into 8 gros, groats or drachms, of 3 deniers or dwt., each of 24 grains. So the livre was 16 × 24 × 24 = 9216 French grains. These were light grains, not the heavy grains, 20 × 24 to the ounce, of English and other mint-weights.

There was a Quintal of 100 livres = 107·7 lb.

The Tonne or tonneau was 2000 livres = 2154 lb.

Value

The French coinage-system, probably instituted by Charlemagne, was the same as ours. The original unit was the silver penny, *estelin* (sterling) or denier (L. *denarius*) of 24 French grains; 12 deniers made a sol or sou (L. *solidus*, shilling) and 20 sols made the livre or pound, originally a livre d'estelins, a 12-ounce pound of sterlings. But the silver coinage shrank and was debased, until, by the eighteenth century, the pound, livre or franc was a silver coin worth tenpence,

the sol a copper halfpenny, and the denier had shrunk, even as copper, to so minute a size that its place was taken by the *liard*, a small copper coin of 3 deniers, a quarter-sou; even the *double* of 2 deniers had disappeared. Accounts were kept in livres and sols and deniers, our £ *s. d.*, but at $\frac{1}{25}$ the present value of our coin.

The *écu* of 3 livres, that is of 60 sous, was largely used; wages of farm-servants are often at the present day reckoned in écus. This was properly a *petit-écu* or half-crown, but the real écu of 6 livres was so little used that the smaller coin took its name. And, as our half-crown has the great convenience of being one-eighth of a sovereign, so the écu had that of being one-eighth of a louis, the gold piece of 24 livres. This was the value of the louis at par, for it varied as did that of the guinea when England was a silver-standard country.

Measures of Capacity

These measures, both the wine-series and the corn-series, were quite discordant and had no relation to the measures of length. That this was caused by an incoherent system of factors is shown by there being in each series a unit derived from the perfectly concordant measures of the South:

The wine-velte = 1·76 gallon, half of the Escandau.

The corn-setier = 34·32 gallons, the Marseilles Cargo.

The former, when increased in water-wheat ratio, is almost exactly $\frac{1}{16}$ of the latter. So, had the former,

increased in this ratio, been multiplied sexdecimally, concordance would have been preserved. But there was a customary Muid = $63\frac{1}{2}$ gallons, our hogshead, with its quarter, our kilderkin, the Quartaut = 15·8 gallons, and not to derange these measures the velte was made one-ninth of the Quartaut. And in the corn-series the Setier was divided and multiplied duodecimally. So the concordance was entirely deranged.

1. *Wine-measures.*—The Velte (the origin of which is given in Chapter XIX) was divided into 2 gallons (our wine-gallon), 4 pots (our pottle), 8 pintes. The last of these, = 1·76 pint, was about our old wine-quart, = 32 oz., its half was a chopine or setier, = our wine-pint, and the half of this was the demi-setier, a name still current, the French equivalent of our popular 'half-pint.'

2. *Corn-measures.*—The standard unit was the Setier = 34·32 gallons, or 4·29 bushels, differing very slightly from the Marseilles Cargo = 4·34 bushels. As the Setier was an isolated measure, while the Cargo was from early medieval times the basis of the complete system of Southern measures, it may confidently be inferred that the Paris unit of corn-measure was taken from that of Marseilles, which was the Egyptian Rebekeh, the cubed Arabic cubit.

The term Setier is the L. *sextuarius*, but it had lost its original meaning and become a general-utility term in measures. The Setier = the Marseilles Cargo of 4 Sestié, must not be confused with this sestié. It was divided into 12 boisseaux of variable standard, but

usually estimated to hold 20 French pounds of wheat. As $\frac{1}{12}$ setier, the boisseau was = 2·86 gallons, and it was divided into 16 litrons = 1·43 pint.

There were intermediate divisions of the Setier; it was of 2 mines (a term taken from the Southern *eimino*), 4 minots, 12 boisseaux.

There was also a Muid for corn and salt. The corn-muid was 12 setiers.

There are still in France traces of an older system of corn-measures derived from the cubic foot. I found, in the Rouen Museum, the standard bushel of the town of Bolbec. It measures 16 inches diameter by 12·6 inches deep = 2533 cubic inches or 9·14 gallons. It appears to be the French cubic foot = 2091 cubic inches increased in water-wheat ratio to 2533 × 1·22 = 2551 cubic inches, a difference probably to be ascribed to the difficulty in measuring at all accurately.

There are also many local standards of capacity, well deserving of study. Some, as the bushel of La Rochelle, indeed of the west of France generally, = 56 lb. of wheat, are much larger than the Paris Bushel. There was a general rejection of the duodecimal division of the Setier.

Table of Old French Measures

Length			Land	
Aune	= 46·77	inches.	Square Toise	= 4·54 sq. yards.
Toise	= 76·73	,,	Square Perche	= 2 sq. rods.
Pied	= 12·789	,,	Arpent (× 100)	= 1·26 acre.
Perche	= 23·446 feet.			

Wine-measure		Corn-measure		Bushels
Muid	= 63·5 galls.	Muid		= 51·6
4 Quartaut	= 15·8 ,,	12 Setier	= 34·32 gall.	= 4·29
9 Velte	= 1·76 ,,	12 Boisseau	= 2·86 ,,	
8 Pinte	= 1·76 pint.	16 Litron	= 1·43 pint.	
2 Chopine	= 0·88 ,,			

Weights

	Quintal	= 107·7 lb.
100	Livre	= 7554 grains.
16	Once	= 472·1 ,,
24	Deniers (dwt.)	= 3 to a 'gros.'
24	Grains.	

Remarks on the French Measures of Capacity

The fault of the Paris system was that there was little or no concordance between the different series.

In length, 6 aunes approximately coincided with 22 feet or $3\frac{2}{3}$ toises.

The measures of length had no concordance with those of capacity, and in the latter, wine-measure and corn-measure had lost their original concordance when they were brought from the south. They lost it by two faults:

1. By making the quartaut of 9 veltes instead of 8;

2. By dividing the setier into 12 boisseaux instead of 8.

Had this octonary division been substituted, it would have been quite satisfactory, and concordance with the linear standard would have been obtained.

A quartaut of 8 veltes, $8 \times 1{\cdot}76 = 14{\cdot}08$ gallons, would have been in water-wheat ratio with the corn half-setier $= 17{\cdot}16$ gallons :

$$14{\cdot}08 \times 1{\cdot}22 = 17{\cdot}17.$$

And the setier divided into 8 parts would have given a larger boisseau $= 4{\cdot}29$ gallons (a peck) corresponding in water-wheat ratio to the double velte of 4 gallons and measuring approximately 1000 cubic pouces (983 exactly) ; its side, when of cubic form, being almost 10 pouces, and thus affording an easily applied linear measurement as a check on the variation of the boisseau. The standard of this measure was most variable from want of such a check. Really, as $\frac{1}{12}$ Setier it should have been $655{\cdot}4$ cubic pouces, but it varied between 644 and 677, its reputed capacity being 640 cubic pouces.

It would have been easy to have fixed the new boisseau at 1000 cubic pouces, raising the variable standard of the Setier to 8000 cubic pouces $= 34{\cdot}9$ gallons instead of its reputed standard $= 34{\cdot}32$ gallons.

By these slight alterations perfect accordance with the southern measures would also have been obtained.

Leaving the measures of length and surface which

were sufficiently concordant, the measures of capacity would have been :

Wine-measure		Corn-measure	
Muid	= 56·32 gallons.	Muid	= 34·9 bushels
			= 4·36 qrs.
½ ,,	= 28·16 ,,	(8) Setier	= 34·9 gallons
Quartaut	= 14·08 ,,		= 8000 c.p.
		(8) Boisseau	= 4·36 gallons
(8) Velte	= 1·76 ,,		= 1000 c.p.
(8) Pinte	= 1·76 pint.	16 Litron	= 2·18 pint.

A water-wheat ratio of 1 : 1·24 would have been preserved between the two series, and their connection with linear measures through a cubic boisseau of 10 pouces each side (or a cylindrical one of 10 pouces diameter and 11·4 pouces in height) would have been most advantageous.

It may seem futile to make these proportions 120 years too late, but they may be useful in showing how unnecessary was the revolutionary plan of uprooting the old measures.

CHAPTER XXII

THE METRIC SYSTEM

THE great diversity in the weights and measures used in different parts of France, and the discordance between the series of the official system, or want of system, were inconvenient, and tended to become more so with the increasing facilities of communication between the provinces. Unification was required, and was being studied at the time when the Revolution broke out.

The obvious plan was to make such alterations in the Paris system as were strictly necessary, keeping to the main standards of length and capacity, standards not irreconcilable, and to make it obligatory throughout France. As Napoleon said, 'It was so simple that it could have been done in twenty-four hours, and adopted throughout France in less than a year.'

Amendments such as I have sketched in the last chapter would have answered the purpose sufficiently.

The ostensible plan of the new system of weights and measures was (May 8, 1790) 'to create them anew on invariable bases, and to establish in commercial calculations the uniformity which Reason has vainly called for during so many centuries, and which must form a new bond between men.'

Even this scientific and fraternal plan, at first on the basis of a normal pendulum-length, $\frac{3}{4}$ inch longer than the half-toise (as proposed by James Watt in 1783), might have been carried out so as to disturb the hereditary ideas and customs of the people as little as possible. But it was resolved to take a geodesical basis. This, taken afresh and not accurately, for the metre, was already at hand in a toise equal to the Olympic fathom, $\frac{1}{1000}$ of the meridian mile. And in the report to the Convention, it was recognised that the most ancient people had measures derived from the terrestrial meridian.

More than two centuries before the Revolution an abbé (Mouton) had proposed a revival of the Olympic system, decimalised from the meridian mile down to a digit, $\frac{1}{100}$ of the fathom.

Without this decimalisation, at least in the popular series of measures, there was a geodesic basis—for this was resolved as necessary—already at hand in the Olympic system, and the Olympic foot cubed would have given a unit of capacity and the Olympic talent one of weight, all the more suitable inasmuch as $\frac{1}{1000}$ of it would have been an ounce = 453·6 grains, closely approximating to the Cologne ounce and therefore likely to be acceptable in other countries. But the real object was to make a clean sweep of the past; and the formation of a Republican system of measures was entrusted to mathematicians and other scientists who did not consider that a system convenient to them might be very inconvenient to unscientific people. The division of all measures must be on an obligatory

decimal system convenient to mathematicians and most inconvenient to nearly everyone else.

The basis of the new system was a measure considered to be one ten-millionth of the quarter-meridian, of the distance from the equator to the pole. This unit was neither original in conception nor exact in measurement. When Aristotle divided the circumference of the globe into 400,000 stadia, instead of the 240,000 stadia of 1000 Olympic fathoms, his stadion, $\frac{1}{100{,}000}$ of the quarter-meridian, was equal to 100 metres. But there was no practical advantage in it, and navigators continued to use the nautical mile of 10 Olympic stadia, as they do to this day.

At least Aristotle did not seek to upset all the weights and measures of the Macedonian empire; and his stadion disappeared.

It is doubtful if absolute exactness will ever be attained in the measurement of the surface of our globe, irregularly spherical in form and of very uneven surface; but there is no doubt that the ancient Chaldæans and Egyptians measured it sixty centuries ago quite as accurately as the astronomers of the first Republic; and the Olympic standard of the meridian mile, not the kilometre, is the unit used to this day by the navigators of France as by those of every other maritime nation.

Having determined with little exactitude the metric decimal fraction of the quarter-meridian, the astronomers and mathematicians of the Republic, *les idéologues* as Napoleon called them, proceeded to

evolve from it the most inconvenient possible units of length, surface, capacity, and weight. All that could be said for these units is that they were exactly and decimally derived from the metre. The metre was unacceptable to the people, as no metric unit of length corresponds even approximately to the universal limb-units of fathom, cubit, foot, span, palm, finger or thumb-breadth. The different series admit only the factors, 1, 2, 5; so each decimal unit has a half (0·5) and a double, but no quarter or third. The prefixes—in Latin for divisions, *deci*, *centi*, *milli*; in Greek for multiples, *deca*, *hecto*, *kilo*, *myria*—give the only names allowed.

Length

The Metre, = 39·370113 inches, is divided into 10 decimetres, 100 centimetres, 1000 millimetres.

1 yard = 0·9144 metre; 1 foot = 0·3048 metre; 1 inch = 0·0254 metre, or 2·54 centimetres.

It is multiplied by 10 for the decametre, by 100 for the hectometre, by 1000 for the kilometre, by 10,000 for the myriametre. Practically the kilometre, = 0·621 mile or 1093·6 yards, is the only larger unit used; the other units are useless. And though it be interesting to know that the kilometre is approximately $\frac{1}{10,000}$ of the quarter-meridian, it is a useless fact.

Surface

The square metre = 1·196 square yard. The lower units are little used. For land-measurement the square decametre, 10 × 10 metres, is called an

Are; 100 ares = 100 × 100 metres, make a Hectare = 2·47 acres; and the square metre is a Centiare.

1 acre = 0·40468 hectare.

Solidity

The cubic metre = 35·315 cubic feet (nearly the volume of a ton of water = 35·84 cubic feet) contains 1000 cubic decimetres, each of 1000 cubic centimetres (= 61 cubic inches).

1 cubic foot = 0·028317 cubic metre.

The cubic centimetre is strictly speaking $\frac{1}{1000}$ cubic decimetre, but as used in chemistry for fluid measure it is considered as $\frac{1}{1000}$ of the litre, which is only approximately a cubic decimetre.

Capacity

The Litre was originally a cubic decimetre, but this definition has been abandoned. It is now defined as the volume of a kilogramme of pure water in air at 4 degrees Centigrade = 39·2° Fahrenheit.

At ordinary temperatures a litre of water weighs about 998·8 grammes or 0·9988 kilogramme (see Table at end of Chap. X).

The only minor unit practically used (and only in scientific work) is the millilitre, under the name of cubic centimetre, = 15·432 grains of water.

1 Litre = 2·204 lb. water, or 1·76 pint.

1 Pint = 0·568 litre; 1 gallon = 4·546 litres.

The principal larger unit is the Hectolitre = 22·04 gallons or 2·75 bushels. The Decalitre = 2·2 gallons.

1 Bushel = 36·37 litres; 1 Quarter 291 litres or nearly 3 hectolitres.

1 Bushel to the acre = 0·9 hectolitre to the hectare. (Deduct $\frac{1}{10}$ on English.)

1 Hectolitre to the hectare = 1·11 bushel to the acre. (Add $\frac{1}{10}$ to French.)

Weight

The original unit was the Gramme, defined as the weight of a cubic centimetre of water at 4° Centigrade = 15·432 grains. It is divided into 10 decigrammes, 100 centigrammes, 1000 milligrammes. Of its multiples the decagramme is useless; the hectogramme is merely the name inscribed on a 100-gramme weight; the kilogramme of 1000 grammes is used when its use cannot be avoided.

But the present legal unit is not the gramme but the kilogramme = 2·2046 lb. or 15,432 grains.[1]

Intended to be the weight of a cubic decimetre of water at 4° C. (as the gramme was that of a cubic centimetre), this definition has been abandoned as inexact; it is now, like our pound, the mass of a certain platinum standard, in a vacuum.[2]

[1] This is a partial return to the original arrangement. The kilogramme was originally named the Grave, with its decigrave and centigrave. The tonne of 1000 kilogrammes was originally called a Bar, with its decibar and centibar. The gramme was a Gravet, with its decigravet and centigravet. Similarly the hectolitre was originally named the Decicade ($\frac{1}{10}$ of the Cade = 1000 litres) of 10 centicades. The litre was a Cadil.

[2] In the latitude of Paris. If weighed at Marseilles it would be equal to about 1000·4 grammes; if in London to 999·75 grammes. It necessarily varies with latitude, as does the length of the pendulum beating seconds. But this variation does not impair its relative accuracy, as whatever it is weighed against is similarly affected.

Practically, the unit of weight in the ordinary transactions of life is the 'half-kilo' of 500 grammes, more usually known as a livre or pound, though the use of this word in trade is punishable.

The livre or half-kilo = 1·1 lb. or 7716 grains.

1 kilo = 2·2046 lb. or 15,432 grains.

100 kilos or Quintal metrique = 220·46 lb.

1000 kilos or Tonne 2204·6 lb. = 0·984 ton.

1 ton = 1016 kilos; 1 cwt. = 50·8 kilos; 1 lb. = 0·4536 kilo or 453·6 grammes.

1 ounce = 28·35 grammes; 1 grain = 6·48 centigrammes.

100 kilos of wheat = 3·53 bushels, at 62½ lb.

100 litres (1 hectolitre) of wheat = 2·75 bushels.

7 fr. duty on 100 kilos wheat = 2 fr. a bushel or 12*s*. 4*d*. a quarter.

1 bushel = 36·4 litres.

Money

The monetary unit is the Franc, practically the same as the old livre, somewhat less. According to the original plan, the Republican franc was to be 10 grammes weight, so that the decimal harmony of the system should not be disturbed. But financial expediency required it to be of about the same weight as before, so 80 old livres were recoined as 81 francs at 5 grammes weight and 0·900 fineness. The franc was to be of 100 centimes instead of 20 sous of 4 liards.

The copper coins, changed to bronze in about 1854, are pieces of 10 and 5 centimes, the latter equivalent to the old sou, so that the franc is commonly

called a 20-sou piece, and the other silver coins, nominally of 5, 2, and $\frac{1}{2}$ franc, are called in the same way *pièces de cent sous, quarante sous* and *dix sous*. The centime is so rarely seen as to be practically non-existent, and the decimal system not allowing the half or quarter of the 5-centime piece or sou, great inconvenience is felt by the poor,[1] yet the symmetry of the system has been marred by the issue of nickel quarter-francs, of a size which makes them often undistinguishable from francs. But this is 25 centimes, while the half-sou would be written 2·5 centimes, marring the symmetry of the centime column in accounts—where practically it would never appear.

Since the adoption of a gold standard under the second Empire, the gold 20-franc piece is the standard of exchange, and of payments in trade. It weighs 6·451 grammes = 99·5635 grains ; it is of 0·900 fineness (= $22\frac{1}{5}$ carats) and thus contains 86·6071 grains of pure gold. Its exchange value is usually 15*s*. $10\frac{1}{2}$*d*., our sovereign being equal to 25 francs 20 centimes.

The system of international currency has led to the French currency containing coins, both gold and silver, of strange devices, and the necessity of placards in shops showing figures of the numerous coins which should not be accepted. Considerable vigilance is necessary to avoid taking coins not current, or taking for francs the nickel five-sou pieces scarcely distinguishable from them except in a good light.

[1] Thus if bread is 25 centimes or 5 sous the kilo, a single pound or half-kilo of bread cannot be bought at this price.

Temperature

The French thermometer, called Centigrade (the proper term would have been centesimal), is on Celsius's scale, of 100 degrees between the freezing and boiling points of water, under the normal atmospheric pressure, which for France is 760 millimetres = 29·92 inches.

Metric Measures of Time

These are dropped, officially, at present; but they may be re-established, for they were the essential part of the Republican system. Ardent republicans constantly claim their re-establishment, and sound republican newspapers, dated according to the republican calendar, take care that this shall not be forgotten. Scientific journals demand the re-establishment of decimal time and decimal degrees; for even to sell eggs or handkerchiefs by the dozen is a sin, and ought to be made a crime, against the decimal system.

Republican zeal, unable to reform the solar system, had to content itself with reviving the ancient Egyptian year of twelve equal months followed by five extra days, to be called Jours Sansculottides, and with instituting a new era. The extra day of leap-years made a sixth sansculottide; these years were therefore sextile, and the period of four years ending with leap-year was to be called a Franciade.

In justice to the authors of the Metric system, it must be said that they were not responsible for the Republican calendar; this was the work of a separate Committee, to whom the Convention handed over the

work carried out by the Weights and Measures Committee of the Académie des Sciences. On August 1, 1793, it thanked the W. and M. Committee for their work, on the 6th it closed all the Academies, and soon after sent the great chemist Lavoisier, the principal member of the Committee, to prison and ultimately to the scaffold. Among the small number of real republicans who ruled France from Paris, there was much less enthusiasm for the metric system, intended to sweep away the memory of the old customs of weights and measures, than for the calendar, the essential part of which was a new era and the sweeping away of past superstitions, whether Pagan or Christian. In both cases one can see the power of a very small but enthusiastic, well-organised and violent minority of Jacobins against the large, but unorganised and terrorised, majority of the French people. In both cases we see the truth of Guizot's saying: 'Blind aversion for the past is full of falsehood and of ignorance.' [1]

The decree instituting the complete Republican system began by these words, characteristic of the times:

> The French era begins with the foundation of the Republic, which was on 22nd September 1792 of the vulgar era, the day when the sun arrived at the true autumnal equinox, entering the sign of the Balance, at 9h. 18m. 30s. a.m., Paris Observatory time.
>
> Thus (it continued) the heavens marked the equality

[1] It had been proposed in 1789 to divide France into equal departments or districts by rule and compass. Each district was to be half a degree square. It was only the refractoriness of the coast line that prevented this geographic homage to equality.

of days and nights at the same moment that civil and moral equality was proclaimed by the representatives of the French people as the sacred foundation of its new government.

The month was divided into three decades and the days of the decimal week were numbered from one to ten.

The saints whose names had been attached to the days were abolished. They were replaced by objects of republican veneration, animals, vegetables, minerals, tools, &c. Each Decadi was consecrated to an agricultural implement, the plough, the watering-pot, the pitchfork, &c.

Each Quintidi was consecrated to a useful animal, the horse, the ass, the pig, the trout, &c.

The eight other days of the decade were consecrated to plants, &c. It was difficult to find 288 useful plants, but by bringing in such as the nettle, the dandelion (under its vulgar French name), strange plants discovered in a herbal dictionary, together with the manure heap and a few useful minerals, the saints were entirely replaced. To popularise these substitutes for the *ci-devant* saints an appendix to the Decadaire or Annuaire (for the term Calendar was abolished as savouring of superstition) gave popular information, in the crudest terms, on the diseases for which the vegetables and herbs were recommended by the scientific advisers of the Republic.

To complete this system, the circles of the globe, and all other circles, were divided into 400 degrees, divided decimally. The day was divided into 10 hours, of 100 decimal minutes, each of 100 decimal seconds.

The republican division of the day was not generally put into practice except in official documents, probably because the Jacobin leaders found it personally inconvenient. Decreed as obligatory in Frimaire, an II, it was suspended in Germinal, an III, yet that it was extant, if not in force, up to 1800 is shown by a police-report of an occurrence on '21 Brumaire an VIII à 2 heures 10 minutes decimales,' i.e. at 5 A.M.

The story of the means by which the unpopular republican measures were enforced has not yet been told. Some idea of it may be guessed from a remark of de Bonald (1817):

> I believe that the same firmness, rigour, and lavish expenditure, used to establish, or rather to try and establish, uniformity of weights and measures, would have been sufficient to establish uniformity of religion.

If in a country which had experienced Louis XIV's system for establishing uniformity of religion, this could be said of the means by which the republican weights and measures were enforced, it is evident that the new system met with anything but the welcome usually supposed.

But a man had arisen who delivered France, for a time at least, from the more objectionable parts of the republican measures, and the good he effected in this way had doubtless much to do with his popularity. From the time of his Consulate, at the end of 1799, the rigour of the system was gradually relaxed. His contempt for the mathematician-advisers of the Republic, whom he had found to be incapable in public

business, was probably brought to a climax by the following event.

The ordnance survey-maps of France were on Cassini's scale of $\frac{1}{86,400}$, i.e. 1 line to 100 toises (which is the proportion of the second to the mean day). A new map having been made on the metric scale of $\frac{1}{100,000}$, Napoleon soon found this out, and ordered the map to be restored to the old scale.

'Je la veux sur l'échelle de Cassini, et je me moque des divisions décimales' (letter to the Minister of War, 1809).

The republican calendar and era were used until the end of 1805, when Napoleon restored the Gregorian calendar and its era; thus 11 Nivose, an XIV, was the last day of the republican system.

But the republican idea of a new calendar and a new era is not dead; it has so little died out that a calendar and era devised by a French mathematician and sociologist in 1852 is now actually used, not only in France, but in England, and also in Brazil, by the followers of this reformer.[1]

[1] In this Positivist Calendar the saints of the old calendar and the agricultural produce of the revolutionary calendars are replaced by great men and women; typical great men, from Moses and Homer to Descartes and Bichat, giving their names to the 13 months, each of 28 days. There is an extra day at the end of the year, and two extra days in leap-year. This system has the advantage of the 7th, 14th, 21st and 28th of the month always falling on the same day of the week.

The Positivist era dates from 1789; and the followers of Auguste Comte, in England, France and elsewhere, thus date 1911 as the 'year 123 of the Great Crisis.'

CHAPTER XXIII

HOW THE METRIC SYSTEM WORKS IN FRANCE

NAPOLEON, who had witnessed the rigorous measures of the Republican government to enforce its metric system, said of it:

> It violently broke up the customs and habits of the people as might have been done by some Greek or Tartar tyrant who, with uplifted rod, wills to be obeyed in all his decrees, regulated by his prejudices or his interests, without any regard for those of the conqueror. . . . It was tormenting the people for trifles.[1]

But he was too wise to disturb trade again by any change in the material standards, however objectionable; he kept these, while abolishing the unpopular decimal series.

The decree of February 12, 1812, accordingly ordered that weights and measures, while being strictly in accordance with the existing standard units, should have 'such fractions and multiples as were generally used in trade and were best suited to the needs of the people.'

[1] The full French text of Napoleon's opinion is given in *Against the Metric System*, by Herbert Spencer (Williams and Norgate, price 3*d*.).

A double-metre became the new Toise, divided, like the old toise, into 6 feet of 12 inches. The Aune was to be 1·2 metre.

The hectolitre and the litre were divided sex-decimally, one-fourth of the hectolitre becoming a double-Boisseau differing very slightly from the old measure of the same name.

The half-kilogramme became the Livre, divided into 16 ounces, these being divided into eighths. The Quintal was 100 livres, the millier 1000 livres, the tonneau 2000 livres.

With regard to money, the gold napoleon being 20 francs and the franc of 20 sous, divided into 4 liards or half-farthings, the system was convenient.

This practical though incomplete compromise was in force until 1837, when Louis-Philippe restored, on paper at least, the full republican system, except the measures of time. Yet the Napoleonic compromise held its ground, and indeed has lost little up to the present day, notwithstanding a more rigorous enforcement of the decimal system under the second Empire and the third Republic.

About 1859 began the propaganda of the metric system abroad. Holland and Belgium, on which it had been imposed when those countries were seized by France in 1792 and 1795, retained it after the peace of 1814–1815; at least the old systems had been destroyed, and it was deemed best to retain the new one, so in 1821 it was compulsory.

The new kingdom of Italy threw away the remains of its metric inheritance from ancient Rome when in

1859 it took the French system, partly perhaps from the apparent difficulty of co-ordinating the measures of the different states, but probably as part consideration for French help against Austria.

Portugal adopted it, on paper at least, in 1863.

The worst was when, in 1868, it was adopted by the North German Confederated States, and when in 1872 it was made compulsory.

It is said that the governing powers of Germany, anxious to unify the diverse systems of its component states, took the fatal step in consequence of English official assurances that the metric system would soon be imposed on the British empire. After this disastrous surrender to international science, the governments of other countries, large and small, civilised and semi-barbarous, were easily induced by skilful diplomacy to impose the French republican measures on their peoples, heedless of the fact that all the persuasion and pressure of the French government had failed to get its own people to use the system whenever it could be evaded.

Herbert Spencer says, of the progress of the metric system:

> When fifty years after its nominal establishment in France the metric system was made compulsory, it was not because those who had to measure out commodities over the counter wished to use it, but because the government commanded them to do so, and when it was adopted in Germany under the Bismarckian regime we may be sure that the opinions of shop-keepers were not asked. Similarly elsewhere, its adoption has resulted from the official will and not from the popular will.

The gradual adoption of the metric system by countries of all degrees of civilisation from Germany and Italy to Venezuela or Haïti, has not been from any desire of the people of those countries for it, except an infinitely small minority of scientists who desire that the whole world should use the system found convenient in international scientific reports, and a somewhat larger proportion of enthusiasts with high and unpractical cosmopolitan ideals. Many also acquiesce from the same motive which induces people to buy a well-advertised and puffed article instead of one to which they had been accustomed and had found satisfactory. They undergo the contagion to which the crowd-mind is so subject. In England a few genuine enthusiasts, and many more who have caught the scientific and cosmopolitan craze, take to the metric system as they take to learning Esperanto, and so long as they have not to use the one in business or the other in conversation, their enthusiasm lasts, especially when it affords opportunities for showing themselves friends of science and progress. But when the contagion spreads so wide that it threatens to revolutionise the habits and customs of a nation and its whole manufactures and trade, the danger is most serious.

The favour which the metric system has found amongst a small proportion of English people is largely due to their ignorance of their own system, an ignorance very excusable when there exists no official statement of our system, or even of its standards. The people are left to the information afforded very badly in

school-books and scarcely better in almanacks. So our system is left without defence against the attacks made on it by well-meaning persons who do not know it, and by the never-ceasing action of the French government.[1] It may therefore be interesting to see

How far the French have adopted the Metric System.

A century of official pressure, of state-education, and of police proceedings against any public selling, marking or crying of goods otherwise than in metric measures and coins, cannot be without some effect, especially in large towns, but even there, while accounts are kept and bills made according to the legal system, the people, as distinguished from the official classes, have never taken to it, and in the country it is nearly entirely ignored, out of official transactions, both in weight and measures and in money.

The sizes of baskets and flower-pots are in *pouces*; lamp-chimneys have their size marked on them in *lignes*. The size of printer's type is in points, each $\frac{1}{6}$ line or $\frac{1}{72}$ of the old French inch; and the printer's pocket-rule is divided on one side into centimetres but on the other into 'Ciceros' corresponding to the English 'pica.'

Barometers for ship-use have their scale usually in pouces and lignes. The port barometer on the quay of the great naval port of Toulon, in front of

[1] Aided greatly by the Alliance Française, an association formed, under government patronage, 'to extend the political and moral power of France . . . and make pacific conquests abroad by its superior civilisation.' Every member of it abroad is bound to promote this cause.

the town-hall, is on this old scale. In 1909 I found the barometer of a new Transatlantique passenger steamer making her first voyage to be 'selon Torricelly,' with its scale in the old *pouces*, 28 = 29·87 English inches.

The sounding line of French ships is in brasses of 5 old French feet, the cable is of 120 brasses, the knot is, as with us, $\frac{1}{120}$ of the nautical mile of 1852 metres; the kilometre being absolutely ignored.

In Southern France the lengths of boats, as at regattas, is stated in páns, taken at $\frac{1}{4}$ metre.

Wine is sold wholesale by the queue, by the barrique, by the feuillette. A barrique or piece of Bordeaux wine is 228 litres, of Burgundy 212 litres. Trade-units are as common in France as in England.

The housewife continues to ask for a four-pound loaf, a *pain de quatre livres*, for a *livre* of sugar, for a *demi-livre* of coffee, for *un quart* of chicory, for a *demi-quart* or for *une once* of pepper. In the market-place, in the streets fruit is openly cried at *quatre sous la livre!* or *deux sous le quart!* when no policeman is within hearing, and the police are discreetly deaf, even in Paris, except when ordered to be more vigilant; but then they kindly give a hint to the costermongers and street-traders and, after a few days of conformity to the law, the cries go on as before.

The grocer does not ticket his wares by the kilo, rarely even by the demi-kilo; he wisely tickets them with a simple 50, or 75, or 80, which means 5*d.*, 7½*d.*, 8*d.*, in coin, 10, 15, 16 sous, for a weight which is not mentioned but is understood to be *une livre*, and which

can be halved and quartered down to an ounce. He finds that his customers are thus better pleased than if the ticket had '½ kilo' marked on it, and he knows that they would be repelled if the price was by the kilo. About the only exception is when the price of goods cannot be expressed in centimes; thus if potatoes are less than, say, 2 sous a pound, the green-grocer has to ticket them '15 le kilo,' 2 pounds for 3 sous. The practical non-existence of the centime, and the refusal of government to coin half-sous or farthings of 2½ centimes, obliges him thus exceptionally to use the word 'kilo.'

When a *quart*, a quarter-lb., say of coffee, is asked for, the grocer has to put into the scale three weights, of 100, 20 and 5 grammes, for a demi-livre two weights of 200 and 50 grammes, instead of being able to use a single half- or quarter-pound weight as under the Napoleonic compromise. For an ounce he gives 30 grammes.

In country towns goods are often openly ticketed in sous; I have even seen 'six liards,' six half-farthings, two for three-halfpence, as the marked price. In the South books and newspapers sometimes have the price boldly printed in sous, '20 sous,' &c. In large shops, especially where there is a cash-desk, the salesmen have trained themselves to speak only of francs and centimes, but the smaller shopkeepers, even in Paris, usually say their prices in sous, at least for prices under two or three francs.

The peasant bargains for cattle in écus (half-crowns) or in pistoles of 10 francs; wages of farm

labourers are still often in écus. Land is reckoned in the old measures according to local custom, and tables of these measures, with their metric equivalents, are given in the 'Usages Locaux' published for the use of *juges de paix* and other officials. Farms to let and land for sale are frequently advertised in these local measures. If the extent is given in hectares, the local equivalent in vergées, seterées, &c., is added. I have such advertisements of recent date.

The master of a government school in Normandy advertised the sale of his haystack by auction. The advertisement (in a newspaper of 1906, now before me) gave the weight of the hay as '5000 kilos (10,000 livres).' He knew that the fathers of his pupils understood, as well as he did, a kilo to be 2 pounds, but he also knew that they would be much readier to bid if the weight was stated in pounds.

Market-prices of agricultural produce are frequently stated by newspapers in the old measures; that of apples is constantly recorded by the barattée, literally the churnful, about equal to our bushel.

The old agrarian measures are used quite close to Paris. I ask a farmer, not six miles from Paris, how much land he has, and he, knowing me to be 'safe,' says so many estrées. How much is an estrée? 1600 square toises is his answer.

I take up a Paris daily paper and see several advertisements of mushroom farms for sale, in the old quarries near Paris; the area of these is always given in toises.

Direct inquiries will always be answered most

favourably to the metric system. The peasant's caution will rarely let the inquirer detect his love of the old weights and measures, quite convenient to him. And the bourgeois, proud of his superior education and glorying in the triumphs of the metric system abroad, ignores the existence of any but the legal system ; he is blind and deaf to the constant evidence which strikes the unprejudiced observer.

The doctor and the druggist would indignantly deny using any other than metric measures, but they have their professional units, necessarily on a gramme basis, though in figures corresponding to ounces, tablespoons, drachms, scruples and grains ; drops (which are actually dropped, not measured) are prescribed, and the mixture is always made up to a total of so many ounces of 30 grammes. And the pharmacien, who is able to read through the frequent ambiguities of prescriptions written in grammes, centigrammes, &c., very likely to be confused, puts the mixture up in bottles which are moulded to show tablespoons of 15 grammes, that is half-ounces.

The druggists' price lists give quantities in units of 30, 125, 250, 500 grammes or cubic centimetres, that is in quantities of 1, 4, 8, 16 ounces ; and these are the quantities in which he usually sells drugs to his customers.

Thus in France there is a chronic struggle between the law and the people ; the system of weights and measures was devised there, not for the convenience of the people, but to suit a decimal theory dear to the mathematical and bureaucratic mind ; the people

must make their convenience fit the system, and it is only by evasions and subterfuges that it can be made to fit, even approximately. The trader has to evade the law if he wishes to retain his customers. The manufacturer, not keeping an open shop, finds evasion easier, and all the circulars addressed by the government to Chambers of Commerce begging them to support the metric system remain without effect. A few months ago a circular deplored the practice of selling and buying silkworms' eggs by the ounce. Recently a circular forbade professors and schoolmasters to utter the names of the old weights, measures or coins, or to allow their pupils to utter them.

The instances I have given of the failure of all the efforts to make the French people take to the metric system are entirely from my personal observation. I conclude them with an extract from Messrs. Halsey and Dale's 'The Metric Fallacy' (New York, 1904) on the failure to convert manufacturers to the system:

> The reasons for the failure of this colossal effort of a century to change the textile weights and measures of France is not difficult to find. The ideas of length, area, volume and weight are as firmly grounded as any that find a lodging in the mind of man. They are bound to the records of the past, to the work of the present, and to the plans for the future. They are ineffaceably imprinted upon the mind of every child to regulate his ideas of extension and weight as long as life may last.
>
> These natural conditions are alone sufficient to account for the failure of the metric system in France. Other influences have however served to make the failure more complete in the textile industry. The metric system

needed something more than the transcendent mathematical faculties of its designers to make it suitable for textile measurements.

The eminent scientists who designed that system were able to solve the most difficult problems in higher mathematics, but failed to comprehend what system of weights and measures was best suited for the carder, spinner, weaver and finisher of wool, cotton, linen and silk. The glamor of their fame failed to make the centimetre suitable for counting 'picks.' Their system had to stand or fall on its merits, and falling has proved that the highest of mathematical abilities is not inconsistent with a dense ignorance of the practical affairs of every-day life.

I strongly recommend Messrs. Halsey and Dale's book to those who wish to know the opinion of American engineers and manufacturers on the metric system.

CHAPTER XXIV

THE CONFLICT OF THE IMPERIAL AND METRIC SYSTEMS

Two systems are face to face throughout the West—the Imperial system resting on long custom and on convenience, and the Metric system on an assumption of science and on revolt against the past. It has been shown that the system which pretends to be the only scientific one, and the easiest, is a failure even in France; but there, like the republic which gave it birth, it is, under the influence of patriotism or national pride, strong for attack abroad while in a state of anarchy at home, worrying manufacturers and evaded in trade whenever police-force fails to have jurisdiction or deems it prudent not to prosecute.

The one makes men fit the measures however inconvenient; the other makes measures to fit those who have to use them. The one attacks; the other apposes a passive resistance.

Let us take a general view of the system attacked.

1. General View of the Imperial System

The Imperial system of Weights and Measures rests on principles quite as rational and scientific as

those of the Metric system, and it is much more practical.

All its series are derived from the English talent, a weight two-thirds of the Roman-Alexandrian talent which was derived from the royal cubit and foot of ancient Egypt.

The original system, of at least ten centuries ago, was as follows:

Length.—The foot was the measure of the side of a cubic vessel containing 1000 Roman ounces of water.

The furlong became at a very early period a length of 40 rods = 220 yards.

The mile, originally 5000 Roman feet, became 5000 English feet, divided into 8 road-furlongs.

Surface.—The acre was one-tenth of the square furlong.

Capacity.—The wine-bushel was the cubic foot, the measure of 1000 ounces of wine or water. $\frac{1}{8}$ of it was the wine-gallon = $\frac{1728}{8}$ or 216 cubic inches.

The corn-bushel was $1\frac{1}{4}$ cubic feet, the measure of 1000 oz. = $62\frac{1}{2}$ lb. of wheat; $\frac{1}{8}$ of it was the corn-gallon = 270 c.i.

Weight.—The pound was 16 Roman ounces = 6992 grains. Its multiples were the 16-lb. stone, the wey of 16 stones, and the true cwt. of 100 lb.

This excellent system has become, after many disturbances, the Imperial system, only differing from the old English system in the following points:

1. The slight rise of the pound (by 8 grains) to 7000 grains.

2. The rise of the wine-gallon to 231 c.i. as now used in America.

3. The unification of the wine- and corn-gallons (the latter still used in America at the standard of 268·8 c.i.) in the Imperial gallon = $277\frac{1}{4}$ c.i. = 10 lb. water.

4. The fixing of the mile at 8 roods or field-furlongs of 220 yards.

5. The optional decimalisation of several series:

(*a*) Of the furlong at 10 chains, of the square furlong at 100 sq. chains, and of the acre at 10 sq. chains.

(*b*) Of weights by the 10-lb. gallon and the 100-lb. cental.

(*c*) Of the ton-register of 100 cubic feet = 100,000 ounces of water.

6. The disappearance of the Troy pound. The Troy ounce must shortly disappear; the 112-lb. cwt. and its stone-divisions are optional.

The Imperial Standards are now:

Length.—The Foot, approximately the side of a cubic vessel containing 1000 ounces of water. The yard of 3 feet or 36 inches.

The Furlong is 220 yards, either—

10 chains of 66 feet or 22 yards, or

40 rods of $5\frac{1}{2}$ yards.

The Mile is 8 furlongs = 1760 yards.

The Nautical mile is 1000 Olympic fathoms = 6080 feet or $2026\frac{2}{3}$ yards.

Surface.—The square furlong is 10 acres; the acre is 10 sq. chains, or 4840 sq. yards, and may be divided into 160 sq. rods.

Volume.—The cubic foot is approximately 1000 ounces of water, = 62½ lb. The Ton-register is 100 cubic feet.

Weight.—The pound, of 7000 grains, is divided into 16 ounces of 437½ grains.

The Gallon of water weighs 10 lb.

The Cental is 100 lb.

The Ton is 20 long Cwt. of 112 lb.

Capacity.—The Imperial gallon = 277¼ c.i. contains exactly 10 lb. of water, or approximately 8 lb. of wheat. It is divided into 8 pints containing 20 oz. of water or 16 oz. of wheat. The Bushel, of 8 gallons, contains 64 lb. of wheat.[1] The Quarter is 8 bushels, which is approximately the quarter, either of a short ton, 20 centals, of wheat, or of a freight-ton of 40 cubic feet.

The principal units, foot, pound, gallon, are connected by their common origin in the talent of 1000 ounces of water. Corrections are needed for accuracy since the pound was increased in Elizabethan times by a little more than 1 per 1000 from its original Roman standard, and since the bushel and gallon were increased by 3 per cent. from the original corn-measure to the Imperial standard.

The co-related units, foot, furlong, acre, pound, gallon, are multiplied and divided by the factors found by long use to be the most convenient to the

[1] The system of the United States only differs from the Imperial system in its retention of the wine-gallon = 231 c.i. and of the corn-gallon = 268·8 c.i.; and in its rejection of the long cwt. for the cental.

people. When no other influence determines the secondary units, the usual factor is 8, or its double, its half, its quarter.

Any unit may be decimalised for purposes of calculation, and several series have alterative decimal series. Thus—

Itinerary and Land measures were decimalised three centuries ago by the chain-series.

The Ton-register of 100 cubic feet, used throughout the world, has a complete decimal series of divisions.

The pound-gallon-cental series are fully decimalised, from the 100-lb. cental down to the septem, $\frac{1}{1000}$ of a pound.

A decimal series of weights from the pound upwards is perfectly lawful. It may be confidently expected that it will before long replace for most purposes the stone and long-hundredweight series imposed in the fourteenth century, and fought against ever since.

Apothecaries' weight, abolished by the Medical Council half a century ago, still lingers in the Board of Trade list of standards. Mint-weight is still on the Troy system. The half-crown is one grain less than an Imperial half-ounce. It may be hoped that it, and other silver coins, will before long be brought exactly to that standard. Already the bronze penny is one-third of the Imperial ounce.

Further improvements will be made. Some adjustment of the inconvenient 112-lb. hundredweight with the cental series, that of our ancient hundredweight, returned to us from America, will probably be

effected. In the meantime we know that our system is progressive.

It may not have such a scientific appearance as that of the metric system. But we must not be dazzled by the word 'scientific.' Our system has its series related with sufficient exactness to have practically as much unity as the metric system; and it is convenient. Let us distinguish between science and pedantry.

2. The Propaganda of the Metric System

I have read many books and many articles and letters in newspapers and scientific periodicals advocating the compulsory use of the metric system, optional amongst us since 1897, but which no trade, industry or profession will adopt, and I have almost invariably found that the writers knew the metric system imperfectly, and always that they knew their own very badly. I have found their advocacy illustrated by examples of problems in imperial weight and measure which showed defective instruction in the art of cyphering and supported by statements which were misleading and only to be char.tably excused on the ground of ignorance.[1] Too often opponents of their propaganda are sneered at as wanting in scientific knowledge, business experience, and common sense.

[1] For instance, in *The Coming of the Kilogram* (H. O. Arnold-Forster) the problem 'How many times is 1 grain contained in 1 ton?' is worked out in a half-page of figures. It can be done in 15 seconds, almost mentally. A cwt. is 112 lb.; a ton is 2240 lb.; multiply by 7000. Answer: 15,680,000 grains (or times).

The propaganda of the metric system is effected, from abroad by diplomacy, and from within by—

1. Calling it 'antiquated,' a term which might be applied to Law, to Religion, to Marriage, to Property, and other ancient institutions.

2. Calling it 'irrational,' when it has that great reason which comes from custom, convenience, improvement in recent times.

3. Calling it 'unscientific,' when it joins to popular convenience the option of decimalisation, whenever that is found convenient, in addition to the alternate decimalisation already established in several series.

4. Putting forward as current certain weights, such as the Troy pound, long ago obsolete.

5. Putting forward as legal measures trade-units, such as the cask, the sack, &c., used for convenience in trade, as much in metric countries as with us.[1]

6. Putting forward, as necessary, sums and calculations which a decently taught schoolboy would laugh at.

7. Ignoring all that is convenient in our system and all that is inconvenient in the metric system.

8. Ignoring the satisfaction of the people of the United States with our system, even when retaining the old wine-gallon and corn-gallon.

9. Ignoring the resistance of the French people

[1] I have even seen it put forward (in a book now before me) that our system has several bushels, indeed thirty is the number given; the ground for this assertion being that bushels of wheat, of oats, or peas, &c., are of different weights. The propagandist supposed no one would think of answering that it is the same with the Hectolitre, which contains different weights of different grains.

to the metric system after a century of education in it and of police-constraint.

10. Urging us to follow the example of other countries that have adopted it, but omitting to find out whether the peoples of these countries, from civilised Germany to barbarous Haïti, use it—so far as they do use it—otherwise than under compulsion. It is the governments of these countries, not the people, that have adopted it, always in the name of Science; and the day police-pressure were taken off, the old system would return, or, at the least, the decimal series would disappear.

11. Threatening loss of foreign trade, when our trade weights and measures are so well understood by foreign manufacturers and merchants that they find no difficulty in placing their goods on our market, and are so well known that many foreign manufacturers find it impossible to use metric standards, those of England being alone accepted in most of the markets to which British manufactures are exported.

12. Calling opponents prejudiced, unprogressive, unscientific, wanting in business experience and common sense.

Such are the arguments used in the propaganda of a system which would make much of the past life of our country unintelligible, send most of its manufacturing machinery to the scrap-heap, dislocate trade for years and bring about in our country the same struggle that is still to be seen in France between the law and the people.

The claims of the metric system are exactly on the same basis as those of the Esperanto language. If the metric system were made compulsory, an energetic body of Esperantists might only have to adopt the metric plan of campaign to get their 'simple, rational, scientific and international' language made first optional, and then, when it was found that no one would use it, compulsory, while the use of the antiquated and unscientific English language would be forbidden.

What will be the result of the conflict between the two systems prevailing about equally in the greater part of the Western world? On the one side North America, the United Kingdom and its colonies in the Eastern Hemisphere; on the other side the Latin nations of both hemispheres with the principal Teutonic nations whose governments have imposed the French system on them. Russia and several other countries are awaiting the results of the conflict. But it is a siege rather than a conflict, for the attack is entirely from France; and though it has the inherent weakness of its system being a failure in the country of its origin, yet the defence has the weakness of its people being so badly instructed in their system that they cannot repel the invasion, and have even allowed the enemy to take up a legal position in their own country. The colonial policy of England, the simple plan of respecting custom, of not interfering needlessly, is very different from that of France. British colonies that were French or Dutch keep the laws and customs that we found there, and amongst these their systems of weights

and measures. If these were convenient they remained, trade bringing a gradual adoption of the English system mixed with local measures; and as these were on a system more or less common to all the Western nations before the French Revolution, weights and measures gradually harmonised. But the policy of France is distinctly aggressive; its colonies must have French laws and the metric system, and other countries also must be induced to abolish their systems and replace them by the system which a century of police-action has not succeeded in making the French people adopt, and which they evade in every possible way.

Why the propaganda of the metric system should have had any success in England appears a mystery—yet it is intelligible to anyone who has observed the contagion of opinions, even the wildest. England has been fascinated by its presentation as scientific and international. This is a scientific age, and every new thing that can be puffed as 'scientific' is likely to take with people unprepared to criticise the science. I have seen the council of no mean English city induced by the word 'scientific' to vote in favour of a petition to make the use of the metric system compulsory; the few members, not one-tenth of the whole, who dared to oppose the resolution being called unscientific, unprogressive, &c.

Repeatedly repulsed, the French siege will not cease its attacks; England, and America also, must be prepared to meet them.

Although the English-speaking peoples have a

system with which they are satisfied, unfortunately few know its principles ; and, in weights and measures as in other matters, an inferior article well advertised supplants an old-established and satisfactory article that is not advertised. If the French people have not revolted long ago against the system imposed on them by the Paris bureaucracy, it is because it is thoroughly advertised as scientific, international, and as conquering the world by the superior civilisation of the French nation. They have been trained to make almost any sacrifices for the glory of France, and so long as they can evade the decimal and other inconvenient portions of the metric system they suffer this patiently for the satisfaction it gives to their patriotic feelings.

But their government must go on conquering, or they may strike against a system which brings in no more glory; as other peoples may when they see that the English-speaking peoples of the world refuse to be persuaded into accepting it.

Here is the weak point of the attack. And when the English-speaking peoples, those of the British Empire and America, are as well instructed in their good system as the peoples of the metric countries are in the bad system imposed on them (and which they evade for all the good teaching of it), the assailants will raise the siege.

We could reply: Amend your own system and make it acceptable to your own people before you ask us to put aside a system which we find convenient and which is founded on better principles than ours.

Our system has been carried to all countries; it is decimal wherever decimalisation is convenient; its international unit is the Ton-register of 100 cubic feet, or 100,000 ounces, as old as the first civilisation of the world, as the civilisation which established the Meridian mile used by your seamen as by ours. We reject an artificial system founded in hatred of the past, and only kept up in its native country by police-force. In the name of decimals you want us to abolish our pound, and use a kilogramme which your own people will not use. It should be enough for you that we have given your system a denizenship by the abuse of which we have been greatly annoyed.

3. The Reform of the Metric System

The defence must be active; then the attack would cease, and the French people, seeing its failure, would demand a reform of the system imposed on them; the other nations suffering under it would follow their example, if indeed the Teutonic peoples did not begin the reaction.

Modifications would be demanded, rendering the metric system less inconvenient for manufacturers, for trade, for the everyday business of life.

The metric standards would be retained, but the decimal system would be optional, left principally for scientific purposes. The divisions and multiples would be in harmony with the customs of each people, usually in sexdecimal series.

For France, the *système usuel* of Napoleon's compromise would be revived. Incomplete a century

ago, it could be rendered complete by the following arrangement of the metric system, suitable both to Northern and to Southern France.

1. The metre to be divided optionally either into 3 feet of 12 inches, or into 4 spans of 9 inches or 12 digits; 2 metres to be a toise and 10 toises a perch; 100 toises or 10 perches to be a centenié (furlong) and 800 toises or 8 furlongs a mile = $1741\frac{3}{4}$ yards. The meridian mile would be 926 toises or $9\frac{1}{4}$ cables.

2. Land to be measured by the square toise, $\frac{1}{25}$ of an are; 1600 square toises to be an arpent of 16 vergées metriques or boisselées, each 10 toises square, = 4 ares.

3. The livre, = 500 grammes, to be divided commercially into 16 ounces of 8 drachms; and for medicinal purposes, the drachm to be 8 oboles of 8 grains. Grammes and decimal fractions of a gramme could be used for scientific purposes.

4. The hectolitre would be divided sexdecimally, into 4 boisseaux, of 4 gallons = $6\frac{1}{4}$ litres. The litre would be divided into 2 setiers or chopines, 4 half-setiers, and 32 ounces.

The equivalence with imperial measures would be approximately:

1 Metre	= $1\frac{1}{10}$ yard.
1 Mille	= 1 mile.
1 Vergée	= $\frac{1}{10}$ acre.
1 Arpent	= 1·6 acre.
1 Livre	= $1\frac{1}{10}$ lb.
1 Litre	= $\frac{9}{10}$ quart.

Similar arrangements could be made in other

countries, the units being made in accordance with the old custom of the people, but always on a metric basis so that international conversion of measures would be easy and accurate.

Envoi

With this suggestion of compromise, of *entente cordiale,* instead of constant aggression by the French system against that of the British dominions and America, I close the last chapter of my work. I took to it twelve years ago for useful occupation in the leisure of approaching retirement from active life in a great seaport. But as I carried out my design I found the verge of the wide subject recede with every advance I made; every fresh field I worked showed another field beyond. A renewal of life for study, travel, observation, would be needed to enable me to carry out at all completely this history of the human mind in one of its most interesting and important aspects. But age warns me to bring my work to a close, leaving its correction and completion to younger men. Yet I hope I have been able to show the principles of unity and of diversity; and apparent confusion becomes clear when the keys of metrology are at hand. The trend of the human mind is always the same; for weights and measures are a part of the daily life of every man and woman. The rise of measurement, the naturalisation of weights and measures brought by commerce, even by conquest, when they are found convenient, the varieties caused by changes of circumstance, the deflections under the constraint of ill-advised rulers, the

effect of long custom in reconciling to new standards if they can only be arranged conveniently, the shifts by which they can be made endurable, the tendency to resume the old trend along another path—all these traits of human nature are shown in this study. One thing is certain, that a wise government sanctions the measures which fit its people ; its business is to maintain unity in the inevitable variety ; and it should distrust the pretensions of science to dictate to men and women, to trade and manufacturers, the measures they shall use. Whether in theocratic ancient Egypt or in revolutionary modern Europe, science is a good servant of Humanity, but a bad master.

Conversion Tables of Metric and Imperial Measures

Centimetres to Inches.	Grammes to Grains.	Kilos / Litres to 10 lb. gallons.
1. 0·39370113	1. 15·432356	1. 0·22046
2. 0·78740226	2. 30·864713	2. 0·44092
3. 1·1811339	3. 46·29707	3. 0·66138
4. 1·5748452	4. 61·72942	4. 0·88184
5. 1·9685565	5. 77·16178	5. 1·10231
6. 2·3622678	6. 92·59414	6. 1·32277
7. 2·7559791	7. 108·02649	7. 1·54323
8. 3·1496904	8. 123·45885	8. 1·7637
9. 3·5434017	9. 138·89121	9. 1·98416

Imperial to Metric Measure

1 inch = 2·54 centim.	1 sq. yd. = 0·836 sq. metre.
1 foot = 30·48 ,,	1 sq. rod = 25·3 ,,
1 yard = 91·44 ,,	1 sq. rood = 1011 ,,
1 mile = 1609 metres.	1 acre = 0·404 hectare.

1 cubic inch water 252½ grs. = 16·38 c.c. or grammes.
1 ,, foot ,, 62⅓ lb. = 28 c. decim. or kilos.

1 grain = 6·48 centigr.	1 hectolitre = 2¾ bushels.
1 ounce = 28·35 grammes.	3 ,, = 1·03 quarter.
1 lb. = 453·59 ,,	1 ,, to the hectare = 1⅑ bushel to 1 acre.
1 gallon = 4·536 litres.	1000 kilos to the hectare = 0·4 ton to 1 acre.
1 bushel = 36⅓ ,,	1 franc a hectolitre = 3·6 pence a bushel.
1 quarter = 2·91 hectol.	1 franc 100 kilos = 22½ pence a quarter.
1 ton = 1016 kilos.	98 pence a ton.

INDEX

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